

THE BARROW DEPOSITING DOCK.

We publish illustrations of the Barrow depositing dock which has been contracted for by Messrs. Clark & Standfield, of London, and is now being constructed at Barrow for the Furness Railway Company, for their use at that port. This dock, which will be the only floating dock in the United Kingdom, is intended to accommodate vessels of nearly 3,200 tons displacement, not only raising them out of the water, but placing them on fixed staging erected along the shore; it is constructed so that it may be taken into two equal parts, each provided with its own engine, pumps, etc.; each half will thus form an independent dock for smaller vessels, and will also be able to raise the other half so that every part of the dock can be readily got at for cleaning and painting.

It will be remembered that the working of this system of dock is altogether different from that of any other. On referring to the plans and elevations, it will be seen that the

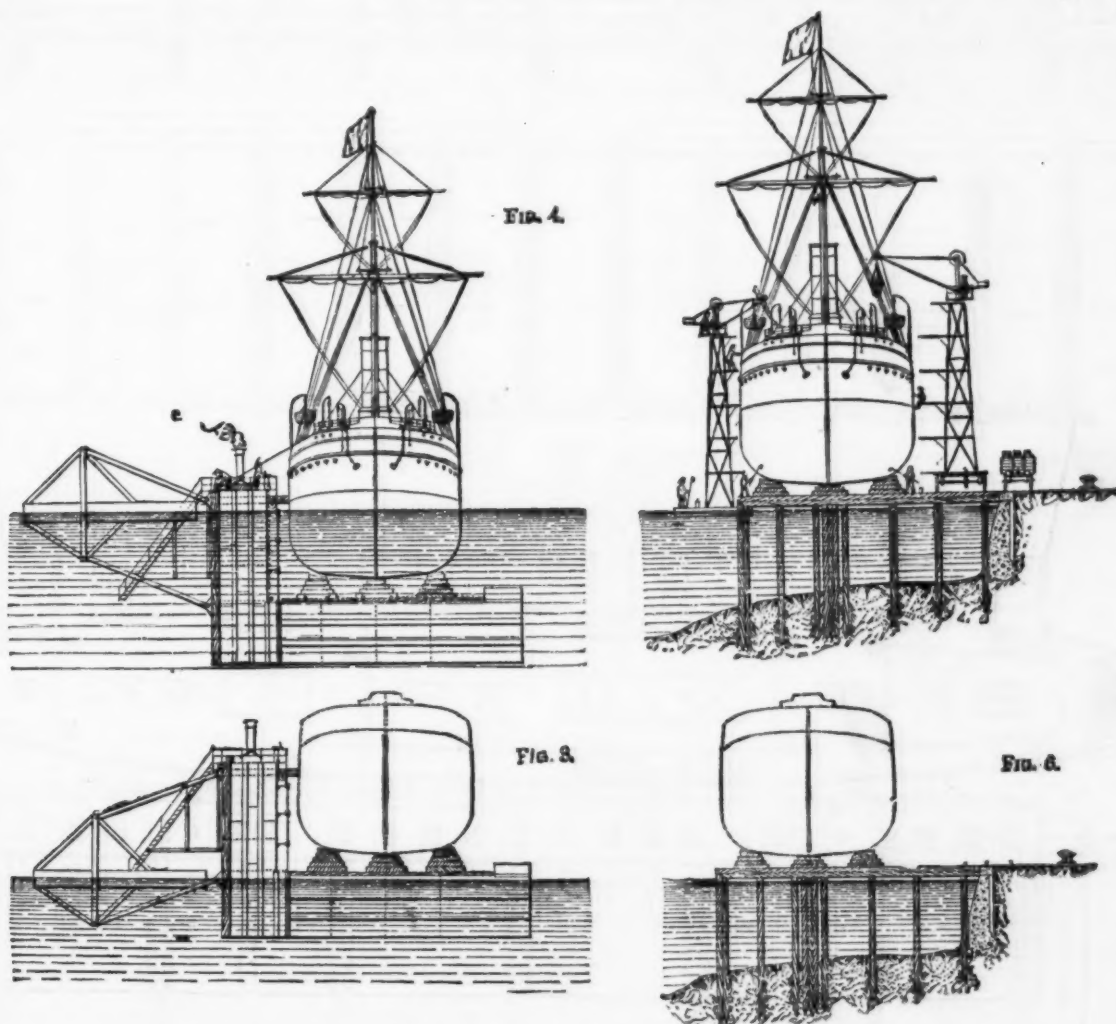
the keel blocks. The bilge blocks are then drawn in by means of chains worked from the upper deck, and pumping is proceeded with until the vessel is quite clear of the water, as shown in outline on the other end elevation.

Thus far the depositing dock has performed only the ordinary operation of raising the vessel out of the water; its specialty, however, from which it derives its name, consists in its being able to deposit any number of vessels high and dry on fixed staging erected along the slope of a wet dock or shore. The staging is constructed of parallel piers of ordinary pilework, as shown in plan and elevations; these piers are about 5 feet broad, and about 15 feet apart.

To deposit a vessel the dock is brought up to the staging, and the pontoons with the vessel on them are entered between the piers. When the vessel has been brought over the keel blocks on the staging, the dock is slightly lowered to allow of the vessel taking a bearing on them; the bilge blocks are then adjusted and the dock is lowered quite clear of the vessel; it is then withdrawn, and is ready to accom-

etc. The shore itself is worked through a tube passing through the side of the dock; to its underside is attached a strong steel rack into which works a pinion on a horizontal shaft; this shaft, which is supported on either side by a strong cast-iron bracket attached to the side of the dock, carries also a wormwheel gearing with the worm fixed on a vertical shaft, at the upper end of which is a large hand-wheel for convenience of manipulating the shore from the upper deck. By throwing the worm out of gear the shore can be very quickly returned into its tube without having to make use of the wheel. After knocking back a pawl, the handwheel is turned in the reverse direction, causing the wormshaft to rise from its working out of gear.

There are in all twelve pontoons, each of which is divided into four water-tight compartments by three transverse bulkheads, namely, one central bulkhead directly under the keel of the vessel, and one intermediate bulkhead on each side of the central one. The whole bottom of the dock is thus divided into 48 watertight compartments. Fig. 8 is a



NEW DEPOSITING DRY DOCK, AT BARROW, ENG.

dock consists of a rectangular box side to which are attached twelve fingers or pontoons forming the bottom of the dock. To the side also an outrigger is attached by means of a parallel motion which allows it always to float, whatever may be the position of the dock itself. The chief function of this outrigger is to preserve the horizontality of the dock during the operations of raising and lowering the vessel. It forms, at the same time, a very convenient working platform and store for spare blocking, tools, etc., as it is connected with the pontoons by means of four gangways passing through the side of the dock, and by two others on the outrigger guides round the ends of the dock, as shown in plan (the outrigger guides have been omitted from the end elevations for the sake of clearness). There are also two large and convenient ladders for communication between the outrigger and the upper deck of the dock; these ladders, which are seen both in plan and in elevation, are so arranged as to be available for use at any level.

When the dock has been lowered by allowing water to enter the pontoons in the usual manner, the vessel is brought over the keel blocks as shown in the end elevations, and is centered by means of traveling side shores, which are placed a little above the water line, and which we shall more particularly mention further on; having secured the vessel by a couple of hawsers, water is pumped out of the pontoons, causing the dock to rise, and allowing the vessel to bear on

modate another vessel. The vessel has thus, without any sliding or rolling motion whatever, been deposited on the staging, as shown in end elevation.

This view shows also on one side a light floating crane and painting stage provided with adjustable platforms; this stage is of convenient size to enter either between the pontoons of the dock, or between the piers of the staging as may be required. On the other side is shown a similar light crane and stage running on broad gauge rails. By means of these floating and portable stages both sides of the vessel may be reached and painted with the greatest facility; the railway may be continued the whole length of the staging, which, at Barrow, will to commence with be made long enough for the accommodation of four vessels.

A spring boom always floats in front of the staging to keep any small craft from entering between the piers; this boom also fits on to the ends of the pontoons, enabling the dock to be slid along the staging into any desired position, either to deposit or to refloat a vessel.

The views on this and the next page show clearly the general arrangement of the dock. Fig. 1 is a side elevation, and Fig. 2 a plan which shows a vessel on the dock ready to be shifted to the fixed staging. Figs. 3 and 4 are end views showing the dock at different levels, and the outrigger. Figs. 5 and 6 show the ship deposited on the fixed platform, and indicate the arrangement of painting stages,

transverse section of a pontoon showing one of these intermediate bulkheads. The skin plating is stiffened every 25 inches by angle-iron frames 6 inches by 2½ inches by ½ inch. Every alternate frame is strengthened by two vertical and two transverse angle-iron struts 4 inches by 4 inches by ½ inch, and these are further stiffened by four longitudinal angle-iron struts running from end to end and secured to each bulkhead by lugs. The frames are also strengthened by double bulb iron 8 inches by ½ inch and 1½ inch on each of the four sides, viz., four lengths on one edge, two on the top, and two on the bottom, and four lengths horizontally, two on each of the vertical sides of the pontoon. These are all placed in contact with and secured to the angle-iron frames, and they are attached to the bulkheads by angle irons. The top of the pontoon is further considerably stiffened by the 4 inch by 2½ inch by ½ inch angle irons for securing the keel blocks or timbers.

All the bulkheads are stiffened by vertical angle irons 6 inches by 2½ inches by ½ inch, placed every 25 inches apart. The central bulkhead is further stiffened by two vertical ¾ inch plates, 20 inches wide, placed one under each of the inner keel timbers; these plates are secured to the bulkheads and to the top of the pontoon by angle irons, and are also stiffened on their other edge by angle irons. The end bulkhead of each pontoon is stiffened at the top by angle-iron diagonals on every alternate vertical angle iron. The raised

chamber occurring on eight of the pontoons forms an integral part of the pontoon, and gives stability as the bilges of the vessel rise out of the water.

The side of the dock is divided into water-tight compartments; the bottom of the uppermost one is formed by an intermediate watertight iron deck placed about 12 feet below the upper deck. The engines and machinery are placed on this deck so as to leave the upper deck perfectly free for the working of the dock.

The outrigger is also divided into watertight compartments; both the side and the outrigger are stiffened by bulkheads and angle-iron frames in the same manner as the pontoons already described.

The dock will be provided with all the usual fittings and with Harfield's double action capstans for taking in cable both fore and aft. The valve gear commanding the various divisions of the dock is placed altogether in a central position on the upper deck, so that the dock can easily be controlled by one man.

We must not omit to mention that this dock has the important peculiarity that, by the insertion of a central section, it can at any time be readily extended in length and increased

cramp be placed with one of its cross bearers on the head of the upper wedge, and the other one on the head of the lower wedge, the effect is to tighten up the wedges and to raise the bilge carriage; if on the other hand they be placed against the points of the wedges, the effect is to slacken them back and to lower the bilge carriage, and this without the use of any battering ram, and without injury to the wedges.

When slackened the bilge carriage is hauled forward or backward by chains and sheaves in the usual manner. The upper part of the carriage is secured from floating away by the chains and clamping screw shown.—*Engineering.*

THE GAMGEE MOTOR.

To the Editor of the Scientific American:

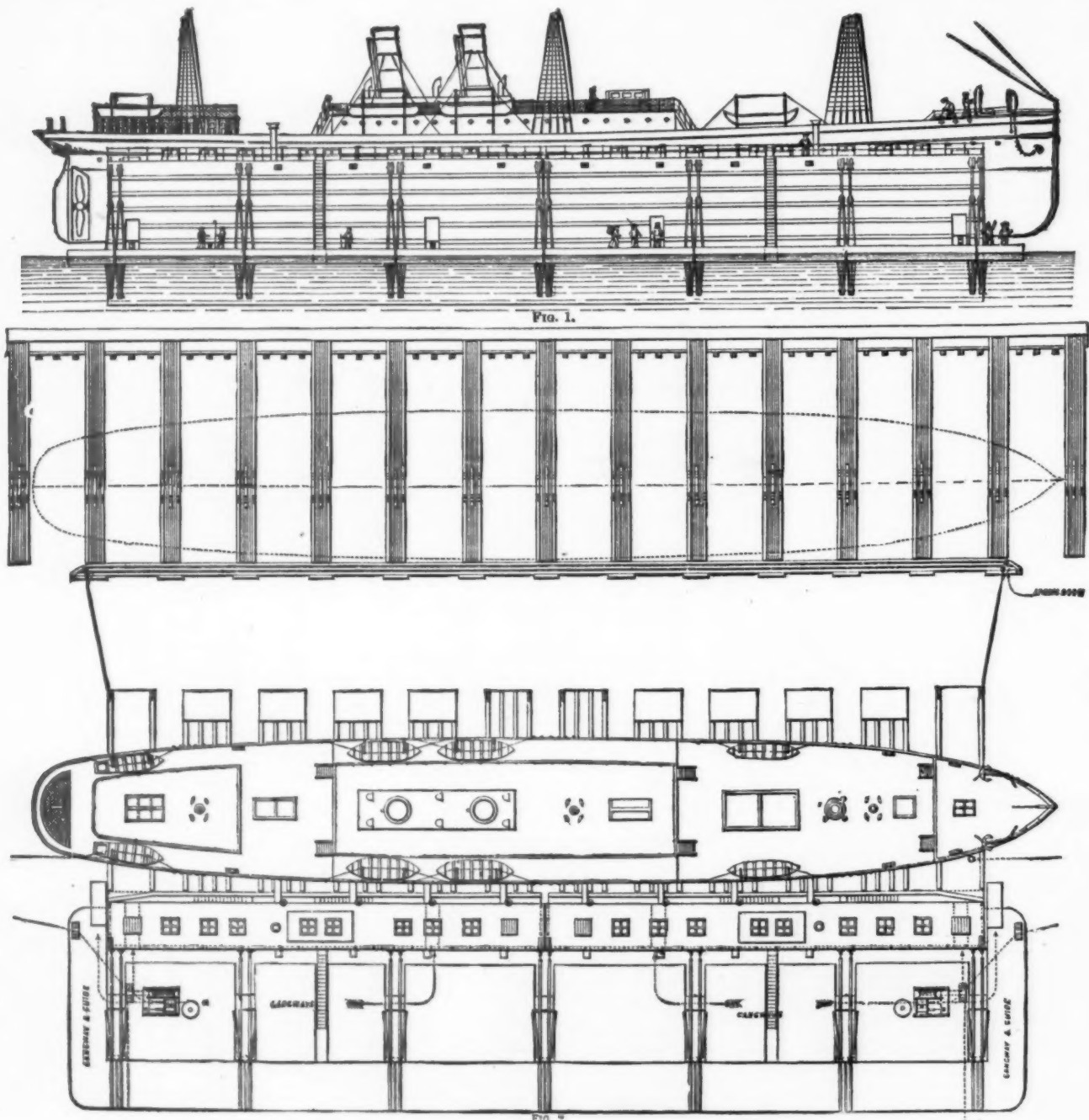
Speaking of Gamgee's zeromotor, July 16, 1881, your correspondent "0=0" says:

"The utter fallacy of the principle on which the zeromotor is based may be illustrated in the following manner:

"The heat stored up in a body is capable of doing a certain amount of work in the same manner as a mass of water stored up in a reservoir.

It has not been "created," for that is impossible. It is, then, the transmitted motion of the imprisoned molecules, and thus we see clearly and distinctly the conversion of molecular into molar motion—the invisible, the potential, has become transformed into the palpable. But what now is the condition of the semi-liberated, semi-expanded gas, now that it has parted with its motion to the piston? Mr. Gamgee answers this question completely and in a manner that ought to satisfy all those who have grown out of the mistakes and misifications of the past. But perhaps he will pardon me if I put his answer in another form.

The motion of the imprisoned gas has been carried off by the advancing piston, and has left the impoverished gas in a state of semi-paralysis and starvation. The vitality which the gas once possessed, and which made it a ready vehicle of motivity, has fled on its mission of work in continuity, and no formulated dogma can arrest its activity or prove that it has gone to destruction. When science and invention have succeeded in again finding this living motion, art and ingenuity will adapt the mechanism to suit the delicacy of its new conditions and put it to useful account. The dynamical equivalent of this motion has never been reached,



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in power so as to dock and deposit vessels of 5,000 tons or even 6,000 tons displacement.

Fig. 12 shows the special sliding bilge blocks employed in the dock, which slide on a frame or carriage broad enough to cover two timbers, and which, by its great breadth, is far more stable than the ordinary blocking, and is able to resist the wash of heavy seas running through the dock. The guiding timbers, A A, are covered with iron, B B, which projects inward between the two beams so as to form holding down slides, and prevent the bilge frame from lifting. Two transverse wedges, C C, form the base of the carriage; they rest upon a large wrought iron plate, D D, and are guided by angle irons; this plate carries lugs, E E, underneath, which prevent it from lifting off the timbers but allow it to slide to and fro freely. On the lower wedges, C C, rest two other oak wedges, F F, having the same inclination, so that the top of the wedges is horizontal; upon these wedges rests a square timber frame, G G, and upon this frame the usual bilge pieces, which are fitted under the vessel and secured by clamps. If the wedges, C C and F F, be pressed inward the upper frame is raised, but if they be withdrawn the whole bilge carriage is slackened and can be removed. In order to tighten up these wedges a hydraulic cramp is employed, actuated by a small hydraulic press. If this

"To make the power available for work it must fall down to and flow off at a lower level. In the same manner, the heat must fall down to and flow off at a lower temperature."

Now I should like to ask, first: Is not this analogy imperfect, and does it not become an "utter fallacy" in itself when viewed through the light of modern research? And second: Is not the writer of this communication confounding matter with motion?

Without further introduction let us take an example.

From the generator of a Gamgee motor we receive a given volume of gas in motion, and we conduct it (for it is not necessary to lift or pump it as in the case of water) behind the piston of the motive cylinder. Here its motion may be scientifically and practically demonstrated, the vibrations of its molecules calculated, and the amplitude of their mean free path measured. The sum of these molecular motions determines the pressure on the walls of the cylinder. The imprisoned gas is struggling for freedom, and now it becomes a question whether the cohesion of the metallic walls or the mobility of the gas is master of the situation. In the end the piston is forced forward laden with the burden of the battering atoms. The piston has acquired motion, and this motion is duly transmitted to the fly-wheel of the engine. But whence came this mechanical motion?

nor can it ever be reached until man becomes endowed with the power to destroy, or with the faculty to put an end to the law of continuity.

The gas having thus been deprived of its excessive motion is no longer a gas, but a liquid, and in this limited and reduced condition it is returned to the boiler to be remobilized and reinstated as a messenger of motion.

But whence the source of this primary motion? In other words, how do we raise the water to a higher elevation, free of charge, so as to obtain and utilize the motion of the fall? The answer is: The water stored up in the higher reservoir answers to the motion of the earth, air, and water that surround us on every hand and in every direction so far as we can penetrate throughout the depths of infinite space. So abundant is this motion that we are blinded by its superabundance. It is not necessary to "create" this motion, for it is already created and complete, every atom and every molecule responding to the motions of the great globe itself. It is our instruments that are at fault, and not the mechanical equivalents of the motion of matter around us.

Why then this foolish opposition and antagonism to Mr. Gamgee, who is as yet struggling to harness and harmonize the working of his invention with that law which is as immutable as the law of indestructibility? We have in Eng-

land sufficient scientific priests, Tories, and stagnationists impeding the pathway of the capable inventor to supply the whole of the American continent, and the rest of the world included, without adding to their number on your side.

In 1872 and 1873 I conducted a series of experiments on the generation and condensation of ammoniacal gas, and to some extent proved to my own satisfaction a truth which I now see clearly, and which I believe sooner or later will develop itself to the downthrow of the dismal deductions which have been so widely drawn from the doctrine of the "conservation of energy." All that we know of "force" and its manifestations is directly or indirectly traceable to motion, and it is to the perpetuity, permanency, or continuity of this motion that the coming battle must be fought.

Any motive engine dealing with the utilization of motion is perfect only in so far as it approximates the perfection of that natural law which proclaims the perpetuity of all motion.

I am well aware of the practical difficulties which are likely to beset the path of Mr. Gamgee in his early trials, but I deny that any of his difficulties are other than mechanical. No physical law is broken, as some of your correspondents would have us believe; on the contrary, the law is on his side. Whatever may be the outcome of Mr. Gamgee's trials one thing is certain, he will have shifted the ground one step nearer the solution of the greatest problem in mechanical science, if he does not actually and distinctly settle the problem, to the amazement of his antagonists.

WM. AMPERE.

Manchester, England.

THE TEHUANTEPEC RAILROAD.

WM. J. McALPINE, consulting engineer of the Tehuantepec Inter-Ocean Railroad, has just returned to New York after four months' absence on the route, and speaks of this really grand enterprise, of which the public know comparatively little, as in full progress toward successful completion. Between 4,000 and 5,000 men are at work, of whom 3,000 are on the northern end, where there are now 15 miles of finished road. As much more will be in operation in a few weeks. At the Southern or Pacific end work was commenced in the middle of April last.

five steam excavator and steam saw mill, besides large quantities of shovels, picks, barrows, corrugated iron for roofing, and other material.

A reason for special satisfaction is found in the selection of Salina Cruz as the harbor at the Pacific terminus, and which will serve as the base of operations on that coast; but the design is eventually to occupy Chipequa, where at no distant day will be one of the finest harbors on the Pacific coast. Altogether, the accounts brought by Mr. McAlpine are of a very cheering nature. The resident chief engineer is Mr. Van Brocklin, formerly engineer of the New York Elevated Railroad.—*Iron Age*.

STANDARD PARALLEL ROD.

THE engraving illustrates the standard parallel rod for locomotives of the Lake Shore and Michigan Southern Railroad, and is copied from the working drawings in the shops of the company at Elkhart, Ind. The rod is made of steel, with solid ends, the ends having openings to take brasses, liners, and keys, similar to those used with straps.

Figs. 4 and 5 are elevations respectively of the rear and front ends. Fig. 1 is a section of the same through C D; Fig. 2 is a top plan of the front end (Fig. 5); E in the several cuts is the liner; F between Figs. 4 and 5 is a section of the middle of the rod.

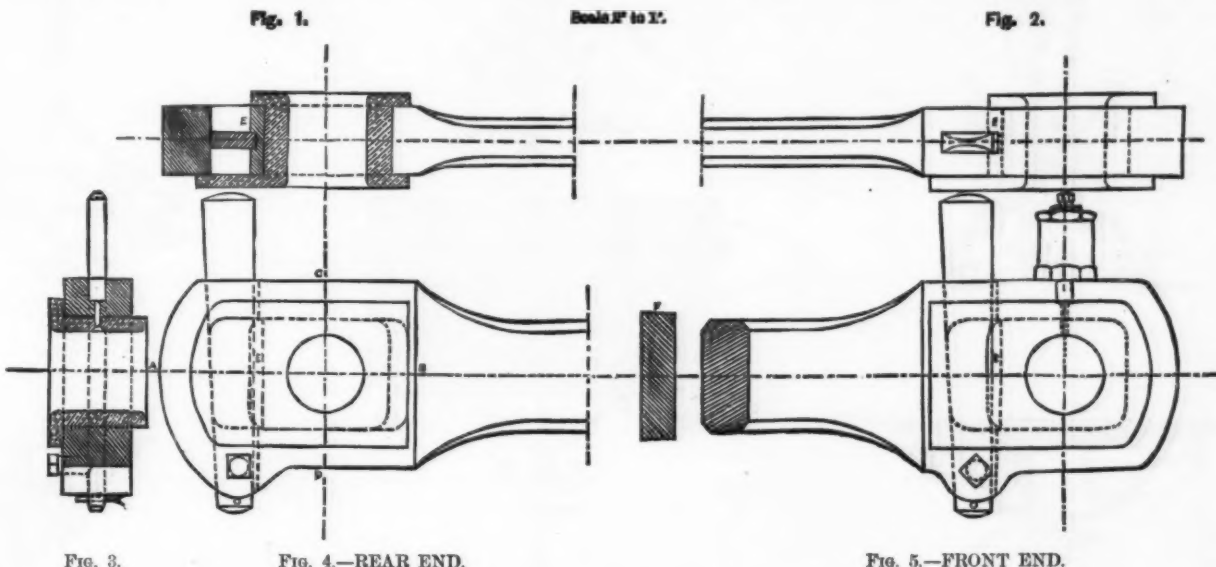
The principal feature of this rod is in the construction of the brasses, which have no top or bottom flanges on the inside, as is shown in Fig. 3, in order to permit their being put in or taken out of the solid ends. When the keys are removed, the openings in the rods are long enough to permit the back halves of the brasses to be taken out past the collar of the crank-pin, and then, after sliding the rod forward, the other halves of the brasses can be taken out. It will be noticed in Fig. 1 that the back halves are held in place by the liners, E, which in turn are held by the keys fitting into the recesses made for them.

The whole arrangement is stronger, and there is not the risk of breaking bolts or losing nuts incident to the stub ends with straps, while retaining all their advantages for taking up lost motion. In fact, it seems to combine all the advantages of both strap and solid ends, and is much more economical in repairs than either. The rod is $4 \times 1\frac{1}{2}$ in. at the neck, but wider and thinner ($4\frac{1}{2} \times 1\frac{1}{4}$) at the center,

The pumps are mounted on substantial bed plates, which also serve as receiving chambers for the water, to which are connected 24-inch mains. The plungers are jointly connected to a central crosshead, and extend into chambers through external packing glands, separated sufficiently to receive slide frames, upon which rests the crosshead sustaining the plungers. As the weight of the plungers is relieved from the sleeves and packing, and carried upon independent adjustable bearings (without interfering with the elements of flotation), the friction is materially reduced, as the packing space can be maintained perfectly concentric. We shall shortly present engravings showing the details of construction of this new form of pumps.—*Min. and Sci. Press*.

BURSTING OF TWO WATER MAINS IN LONDON.

Soon after nine o'clock on the morning of a July Monday, the Grand Junction Water Company's trunk main burst in Goldhawk Road, Shepherd's Bush. The pipe being 30 inches in diameter, and connected with a large head of water, a serious flood was occasioned. A portion of the roadway was thrown up, but little or no damage was done to private property. The accident was promptly repaired; but the loss of water, coming at a time of temporary scarcity in parts of the company's district, added greatly to the inconvenience of the consumers. The cause of the accident was at once made the subject of inquiry, and a meeting of the Court of Directors was held, when a report upon the damaged main was presented by the Company's engineer, Mr. A. Frazer. In this report it is stated that, on Sunday, July 17, every effort was made to fill one of the Campden Hill reservoirs, the water being driven at a great speed through the old 30-inch main from ten o'clock in the morning. This was continued throughout the day and night, and by six o'clock on Monday morning the reservoir was nearly full. To accomplish the object in view, it was necessary that the 30-inch cock near Campden Hill Road, on the line of the mains leading to town, should be partially closed, in order to check the great draught of water, and divert it into the reservoir. Upon attempting to open it again the thread of the spindle broke, and the valve closed. It could not then be reopened, but the shock was sufficiently severe to drive out the lead joint of a double collar on the same line of main near Shepherd's Bush Common. So extensive a



PARALLEL ROD FOR LOCOMOTIVES.—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

We were favored by Mr. McAlpine with full information. He was asked how the prospects of the Tehuantepec route compare with the proposed Lesseps Canal or Eads' great ship canal, which secure so much more of public attention. Said he: "Two years from now we shall have the route through and in operation from ocean to ocean. Lesseps's, it is said, will be finished in 10 to 20 years, and Eads' canal will be nearly or quite as long in building. Each of those works will cost not less than \$500,000,000, the annual interest of which would pay a dividend of 300 to 400 per cent. on the investment in the Tehuantepec Railway, viz., \$6,000,000. Hence," said Mr. McAlpine, "competition between these works is out of the question." He added that if the traffic contemplated by the projectors of the Eads scheme is realized as to volume, two tracks on the Tehuantepec road would do the whole of it, and such two-track railroad would cost less than \$10,000,000, against the \$500,000,000 required for either of the other projects.

For those who are not familiar with that part of Mexico bordering on the Gulf, it may be observed that the Tehuantepec road (for which Mr. Edward Larned, of Pittsfield, Mass., obtained a full concession) will run very nearly north and south, the northern terminus being at the mouth of the Coatzacoalcos River, which is almost due south from New Orleans. Its length will be 160 miles, and the saving in distance between New York and San Francisco, compared with the Panama route, will be 1,152 miles each way, or, compared with the voyage around Cape Horn, 21,534 miles on the round trip. According to Mr. McAlpine, who has carefully surveyed the entire line, there are no unusual difficulties in building the road, as the grade nowhere exceeds 60 feet to the mile, and more than one-half of it is of the cheapest construction, nearly following the surface of the earth. The most expensive portion of it, and that extending a short distance only, will not exceed \$60,000 per mile, making an average for the whole of not more than \$25,000 or \$30,000 per mile.

So quietly has the work proceeded that many will be surprised to learn that no less than 33 cargoes of material have been shipped to the Coatzacoalcos River up to the present date, most of them from New York, though the rails go from England, and about 50,000 ties from Florida. Most of the ties, however, are found on the spot, comprising mahogany, rosewood, and grisea, the two latter having a close resemblance. Lately, the chartered steamer Vidette left this port, taking out a number of engineers, a locomotive

which gives greater resistance against vibrations at the center when running fast.—*Nat. Car Builder*.

LARGE PUMPING ENGINES.

At a recent visit to the machine works of Messrs. Goss & Adams, 114 and 116 Beale street, San Francisco, we witnessed the starting up and trial of one of a pair of enormous direct acting plunger pumps, built by this firm (and of which they make a specialty), for the new California Sugar Refinery, now being erected by Messrs. Spreckels on the Potrero. The pattern was devised by Mr. Geo. E. Dow, constructing engineer of the firm, who has secured, through the *Mining and Scientific Press* Patent Agency, several patents upon this pump, so it is purely a home production. The pair of pumps weigh 50 tons, a statement which will give an idea of their great size, and they are among the largest ever constructed in this city. They stand each 17 ft. 6 inches high, and 26 ft. 6 inches long.

The dimensions are as follows: Diameter of steam cylinders, 30 inches; diameter of plungers, 26 inches; length of stroke, 36 inches. The combined capacity of the pumps is 8,000 gallons a minute at a height of 100 ft., or nearly 500,000 gallons per hour. They are intended to be used for cooling and condensing purposes at the sugar refinery, pumping salt water from the bay. The pair of pumps is set on a very solid foundation in the basement of the building, their suction pipes leading to a reservoir or well connected by a bricked tunnel with the bay. The flow of water is controlled by suitable valves or gates, arranged so that they can be easily lifted at any time, even with a heavy pressure on one side. A very complete series of screens for preventing the entrance of fish, dirt, etc., has been arranged by Mr. Watson, the superintendent of construction at the refinery, who also devised the form of gate controlling the flow of water.

Aside from the direct improvements introduced on these pumps by Mr. Dow, the general design shows a proper consideration of proportion and detail, simplicity and accessibility to all working parts being prominent.

The engines are operated with Dow's latest improved valve motion, which controls the motion of the piston completely, being perfectly free from the convulsive action, and controlling the length of stroke to a nicety. The performance of the pumps under the variable test to which they are subjected reflects credit on both builder and designer, and was perfectly satisfactory to the purchaser.

leakage of water was thus caused that the engines at Kew were of necessity stopped, and the main emptied while the joint was being repaired. The accident, the engineer stated, occurred at half-past nine o'clock in the morning, and the repair was completed and the main recharged by half past eleven at night, the accident to the valve having been remedied by the same time. On Wednesday evening, between eight and nine o'clock, another water-main burst. It appears that at the time mentioned water was seen oozing from the pavement at the junction of Shepherdess Walk with the City Road. The stones were gradually raised, and as the force of water gained strength were thrown from their places, and the pavement was torn up for a space of several square yards. As speedily as possible the supply was turned off. It was then discovered that the burst pipe was a branch main leading from the much larger mains laid in the City Road. The officers of the New River Company, in whose district the accident occurred, were communicated with, and men were at once set to work to repair the damage. The injury is supposed to have been caused by over-pressure consequent upon the extra exertions of the company to prevent any deficiency in the supply which might have resulted from an unusually heavy consumption of water consequent upon the then prevailing high temperature.

IMPROVEMENTS IN THE TREATMENT OF FLUID BLAST FURNACE SLAG.

By A. D. ELBERS.

FURNACES in which iron ores in contact with charges of fuel and flux are smelted down to pig iron are called blast furnaces, and the molten earthy dross which separates from the metallic iron while in fusion, and which gathers on account of its lighter weight on top of the metal, is called slag or blast furnace cinder.

In the United States the output of pig iron averages perhaps somewhat above that of the weight of the slag; still over three million tons of the latter are yearly produced, whereof only a small part is utilized, whereas the accumulation of the remainder is a decided incumbrance.

Though the ballasting of roads, filling in of embankments, etc., occasionally afford a ready market for the slag of some furnaces, the money value derived therefrom is no adequate return for the cost of the heat which was used in melting the slag, the total cost of which is to this country alone nearly equal to that of a million tons of coal yearly.



SUGGESTIONS IN DECORATIVE ART.—WROUGHT IRON OBJECTS: WOOD BASKETS, CANDLE STANDARDS, UMBRELLA STAND, WINE COOLER, MUSIC DESK. DESIGNS OF M. ZAAR, BERLIN.—From *The Workshop*.

The utilization of this waste heat, which is now generally allowed to escape from the slag as best it can, thereby actually injuring the quality and properties of the latter even for the commonest use, is therefore of the highest importance, and all attempts to render blast furnace slag valuable should be in the direction of manipulating it in its state of fusion, and of either utilizing its heat directly, or to regulate the rapid escape of heat in such manner as to obtain the most desirable state of molecularity in the solidified slag, or that condition in which the latter will be most useful.

The production of the now well-known substance "mineral wool," of the so-called "slag sand," the use of fluid slag in the manufacture of bottle glass, and the recent French experiments of running the slag from the blast furnace into rotary gas furnaces for further conversion into artificial stones, are all efforts in the right direction, but as

yet absorb only a comparatively small quantity of slag abroad, and probably not one per cent. of the yearly supply in this country.

Usually the slag is allowed to run through gutters or along a chute into furrows on the ground, and then becomes quickly chilled on the surface, and from under the still liquid mass runs onward and breaks out in new streams, which become crusted over in their turn, until the flowing supply is exhausted, when also the cores of the slag streams solidify.

It is obvious that the almost simultaneous transformation in the same piece of liquid into solid and irregular contraction of the already solidified crust, while the slag is undergoing a loss of heat of nearly 2,000° Fahr., all within about ten minutes, is less apt to promote molecular uniformity than an incongruous material of haphazard shape.

It must be remembered here that slag is by no means as ductile as glass, but rather "red short" or "refractory," that the composition of the average blast furnace slag contains much more lime and less of silica than glass, and that the vitreous condition of slag may or may not be obtained, according to the manner in which it is cooled, as can be best illustrated by a closer examination of the slag product "mineral wool."

If this wool is made from very "limy" or "calcareous" slag, poor in silica, and the fine wool flock is put into a bottle which contains diluted vinegar, the fine wool threads will entirely melt away or dissolve in a day or two, whereas the slag globules which are generally found in the wool scarcely change at all, if kept in the bottle for months. Still the globules and threads are of exactly the same position, only the globules offer in proportion to bulk

smaller surface to the action of the acid, and, having been suddenly chilled by contact with steam jets, are more vitrified on their surface than the elongated and slower cooled threads.

Compactness and vitrification of the slag prevent, therefore, its gradual decay and disintegration under exposure to the weather.

The following description of a new method of treatment, for which letters patent have been recently granted to Mr. A. D. Elbers, of Hoboken, N. J., through the agency of Messrs. Munn & Co., may incite a more general investigation of the possible uses to which blast furnace cinder can be put.

It is proposed to run the fluid slag from the furnace into a revolving spider, resembling an ordinary carrousel. Instead of the platform for wooden horses and riders, the circumference of the apparatus is encircled by an annular iron trough or gutter, into which the slag is to flow, while the carrousel swings around.

Assuming the slag yield from a given furnace to average 5,000 pounds at every tap, and this quantity to be poured out to a depth of 6 inches into a gutter one foot wide, or to a depth of 3 inches in a gutter 2 feet wide, the capacity of the gutter would have to be about 30 cubic feet, the outer circumference 60 feet, and the diameter of the whole apparatus about 19 feet.

If the apparatus made 5 revolutions per minute (as an ordinary carrousel of that size can be made to do by hand power), the slag-flow would be distributed over a distance of 300 feet in one minute, or over 2,100 feet in 7 minutes, which is about the time in which the 5,000 pounds of slag would have run in.

In this manner the slag will be cooled quickly, and the hotter or liquid strata will always be on top of the colder and already solidified layers, and thereby insure solid weld, density, and compactness of the whole mass.

While the various forms into which the slag may be cast will suggest themselves in practice, that shape which may be most desirable for its utilization as railroad ballast, presumably the most extensive application to which slag can be put, will certainly be obtainable at about the same cost as removing cinder in the old way. Common ballast for railroad construction and maintenance of way is not generally procured further off from where it is to be used than 20 or 30 miles. The possibility of getting material of a shape and quality to suit the more exacting requirements of first class roads, as regards freedom from dust, preservation of cross-ties, and stability of road-bed, may, however, allow of more extended transportation, and thereby render available the slag from blast furnaces, which would otherwise be considered too far off to draw a supply from.

THE MANUFACTURE OF GLASS FOR DECORATIVE PURPOSES.*

By H. J. POWELL, B.A.

"THE manufacture of glass for decorative purposes" is a subject of considerable extent, and requires more time to do justice to it than is at present available. The subject may conveniently be divided into three parts: 1. The development for decorative purposes of the natural properties of glass; 2. The production of decorative forms, or decorative material, by the manipulation of glass in a plastic or viscous condition; 3. The treatment of the surface of glass with a view to supplement the effects due to its form or its nature.

I. NATURE OF GLASS.

Glass is defined as an amorphous transparent solid, and the existence of devitrified glass, which is both crystalline and opaque, and of other opaque glasses to which I hope to allude, need not materially damage this definition. There are many different glasses, but all agree in being built up of compounds which are called silicates, a silicate being formed by the union of the oxide of silicon, or silica, with another oxide. The large family of silicates may be divided into two groups, the one being composed of alkaline, and the other of the metallic silicates. It is only necessary to mention a few individuals belonging to each of these groups, namely, those of the first group, which respectively contain the oxide of potassium and the oxide of sodium, and those of the second, which contain the oxide of lead, the oxide of calcium, and the oxide of barium. Every glass must contain at least one silicate belonging to the group of alkaline silicates, as well as one silicate belonging to the group of metallic silicates. Manufacturers have practically nothing to do with silicates as silicates, but knowing that the nature of a glass depends upon the natures of its constituent silicates, they put into their crucibles materials of such a nature, and in such quantities, as will produce the silicates, and consequently the glass, which they require. The raw materials are, as a rule, oxides or carbonates; a carbonate being a compound of an oxide with the oxide of carbon or carbonic acid. The most important materials are sand (an impure form of oxide of silicon), red lead (a mixture of the oxides of lead), and the carbonates of potassium, sodium, barium, and calcium. The whiteness of the resultant glass depends upon the purity of the raw materials, and especially upon the absence of iron, whether as an oxide or as a metal. The silicate of lead is formed by the direct combination in the crucible, under the influence of intense heat, of sand with the oxide of lead. The silicates of potassium, sodium, barium, and calcium, are also formed in the crucible by the indirect action of the sand upon the respective carbonates. This indirect action consists in the expulsion of carbonic acid gas from the carbonate by the intensely heated oxide of silicon, and the consequent union of the latter with the residual oxide. Given the alkaline and metallic silicates required to form a certain glass, the necessary raw materials for the required silicates are simultaneously thrown into the crucible, and the silicates will be simultaneously produced by the action of the heat of the furnace in which the crucible has previously been "set."

The simplest form of a glass furnace is a circular base, covered by a flattened dome. In the center of the base is a comparatively small grate, and round the grate, under arches formed in the wall of the dome, the crucibles are placed. Flues pass through the dome at the side of each arch, which direct upon the crucibles the heat and flame reflected from the center of the dome. The arches serve for the introduction and removal of crucibles as well as for the removal of glass from the crucibles, when required for manipulation. Crucibles are built of fire-clay, roll by roll, and their shapes are regulated according to the nature of the mixtures which they are intended to hold. If the mixture for a glass contains oxide of lead, it must be pro-

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Different glasses possess different qualities, according to the number and nature of their constituent silicates. As a general rule, a glass containing two silicates is less fusible, but considerably purer in color and texture, than one containing a larger number. A homogeneous glass is more easily obtained when its constituent silicates are of similar



FIG. 1.—FURNACE.

or approximate specific gravity. Plate and sheet glass, composed of the silicates of sodium and calcium, are generally homogeneous, but possess a green tinge, due to the silicate of sodium. Crown glass is white, owing to the replacement of the sodic silicate by silicate of potassium. Flint glass, consisting of the silicate of lead and silicate of potassium, is both white and brilliant. The brilliancy of flint glass is due to the density of the lead silicate, but this very density is frequently the cause of striae and irregularities in the substance of the glass. It is almost as difficult to obtain a clear mixture with the silicates of lead and potassium as with water and oil. The silicate of barium is



FIG. 2.—CRUCIBLES

used for pressed glass, as a cheap substitute for the silicate of lead. Venetian glass contains three silicates—namely, those of sodium, calcium, and potassium; it is therefore fusible, and its density is trifling. To these two properties the lightness and intricacy of Venetian work are to be attributed. Venetian glass is generally devoid of brilliancy, and very far from being either white or homogeneous, but these very deficiencies give that horny effect which is looked upon as a characteristic beauty. Bohemian glass, in addition to the silicates of sodium, potassium, and calcium, contains traces of the silicates of magnesium and aluminum. It is fusible, easily manipulated, and develops, with the sub-oxide of copper, a ruby color, which



FIG. 3.—PRINCE RUPERT'S DROPS.

cannot be attained with a glass containing silicate of lead.

When fusion and purification are complete, the glass in the crucible is in a condition closely resembling that of very glutinous treacle. It can be withdrawn from the crucible by pouring, by ladling, or by gathering. Gathering consists in thrusting the heated end of a hollow iron rod, measuring from five to six feet, into the molten mass, and turning it so as to collect a coil of the semi liquid material. It requires some skill and practice to collect the exact weight of glass required to reproduce a given pattern, especially as a mistake in this, as in all processes of glass manufacture, is irrevocable. The molten glass, as it comes from the

crucible, may be considered to be physically porous, as heat produces mutual repulsion between the molecules of a body. These physical pores have to be closed by a very gradual process of cooling, for if the process be hurried, the outer crust will be solidified, while the interior remains in a porous condition. So-called toughened glass has failed, because however hard the surface may be rendered by the violent contraction caused by sudden cooling, the interior remains porous, and the unnatural tension excited between the interior and the surface generally ends in the destruction of both.

Gradual cooling, or "annealing," is practically effected by placing the glassware immediately after manipulation upon movable trays, and slowly removing them in a continuous train from a constant source of heat, or by placing

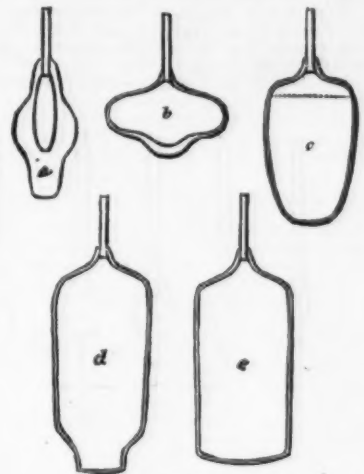


FIG. 4.—SHEET GLASS.

the ware in a heated oven or kiln, and allowing the source of heat to die out.

The effects produced respectively by the refraction, transmission, or reflection of light by glass may, in many cases, be utilized for decorative purposes. If a beam of light be transmitted through a glass prism or luster, a more or less extended spectrum is formed in proportion to the density of the glass. If white light be transmitted through glass containing the oxide of uranium in solution, rays otherwise unseen become brilliantly conspicuous. If certain metallic oxides be introduced into a crucible, together with the mixture for transparent glass, and be dissolved throughout the

mass, the resultant glass acquires the power of sifting the incident rays, and of transmitting effects of color, according to the nature or quantity of the oxide introduced. Different permanent transmitted colors are obtained (1) by the oxides of different metals, (2) by the different oxides of the same metal, (3) by different quantities of the same oxide, or by different thicknesses of the resultant glass. The charac-

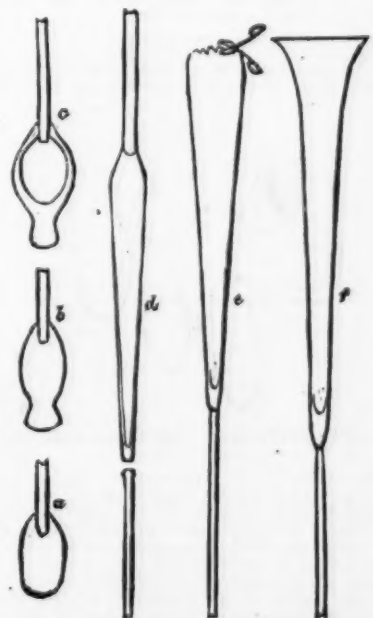
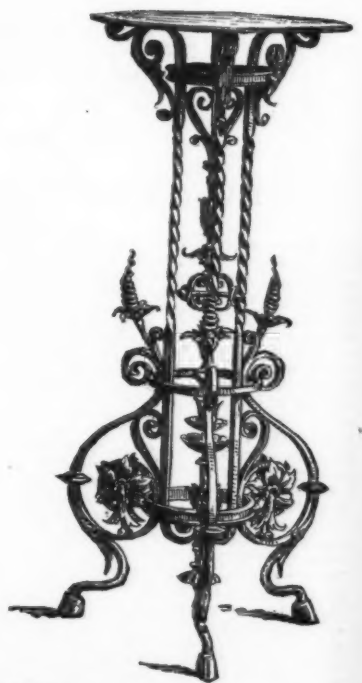


FIG. 5.—LONG VASE.

teristic colors of the oxides of gold, silver, copper, manganese, iron, and cobalt are, respectively, pink, yellow, peacock-blue, violet, dull green, and purple-blue. Copper and iron possess two oxides each, namely, a peroxide containing a large proportion of oxygen, and a sub-oxide containing a smaller proportion. The peroxide of copper gives a blue or

* A paper recently read before the Society of Arts.

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SUGGESTIONS IN DECORATIVE ART.—WROUGHT IRON OBJECTS: WOOD BASKETS, CANDLE STANDARD, UMBRELLA STAND, WINE COOLER, MUSIC DESK. DESIGNS OF M. ZAAR, BERLIN.—From The Workshop.

The utilization of this waste heat, which is now generally allowed to escape from the slag as best it can, thereby actually injuring the quality and properties of the latter even for the commonest use, is therefore of the highest importance, and all attempts to render blast furnace slag valuable should be in the direction of manipulating it in its state of fusion, and of either utilizing its heat directly, or to regulate the rapid escape of heat in such manner as to obtain the most desirable state of molecularity in the solidified slag, or that condition in which the latter will be most useful.

The production of the now well-known substance "mineral wool," of the so-called "slag sand," the use of fluid slag in the manufacture of bottle glass, and the recent French experiments of running the slag from the blast furnace into rotary gas furnaces for further conversion into artificial stones, are all efforts in the right direction, but as

yet absorb only a comparatively small quantity of slag abroad, and probably not one per cent. of the yearly supply in this country.

Usually the slag is allowed to run through gutters or along a chute into furrows on the ground, and then becomes quickly chilled on the surface, while from under the still liquid mass runs onward and breaks out in new streams, which become crusted over in their turn, until the flowing supply is exhausted, when also the cores of the slag streams solidify.

It is obvious that the almost simultaneous transformation in the same piece of liquid into solid and irregular contraction of the already solidified crust, while the slag is undergoing a loss of heat of nearly 2,000° Fahr., all within about ten minutes, is less apt to promote molecular uniformity than an incongruous material of haphazard shape.

It must be remembered here that slag is by no means as ductile as glass, but rather "red short" or "refractory," that the composition of the average blast furnace cinder contains much more lime and less of silica than glass, and that the vitreous condition of slag may or may not be obtained, according to the manner in which it is cooled, as can be best illustrated by a closer examination of the slag product "mineral wool."

If this wool is made from very "limy" or "calcareous" slag, poor in silica, and the fine wool flock is put into a bottle which contains diluted vinegar, the fine wool threads will entirely melt away or dissolve in a day or two, whereas the slag globules which are generally found in the wool will scarcely change at all, if kept in the bottle for months. Still the globules and threads are of exactly the same composition, only the globules offer in proportion to bulk a

smaller surface to the action of the acid, and, having been suddenly chilled by contact with steam jets, are more vitrified on their surface than the elongated and slower cooled threads.

Compactness and vitrification of the slag prevent, therefore, its gradual decay and disintegration under exposure to the weather.

The following description of a new method of treatment, for which letters patent have been recently granted to Mr. A. D. Elbers, of Hoboken, N. J., through the agency of Messrs. Munn & Co., may incite a more general investigation of the possible uses to which blast furnace cinder can be put.

It is proposed to run the fluid slag from the furnace into a revolving spider, resembling an ordinary carrousel. Instead of the platform for wooden horses and riders, the circumference of the apparatus is encircled by an annular iron trough or gutter, into which the slag is to flow, while the carrousel swings around.

Assuming the slag yield from a given furnace to average 5,000 pounds at every tap, and this quantity to be poured out to a depth of 6 inches into a gutter one foot wide, or to a depth of 3 inches in a gutter 2 feet wide, the capacity of the gutter would have to be about 30 cubic feet, the outer circumference 60 feet, and the diameter of the whole apparatus about 19 feet.

If the apparatus made 5 revolutions per minute (as an ordinary carrousel of that size can be made to do by hand power), the slag-flow would be distributed over a distance of 300 feet in one minute, or over 2,100 feet in 7 minutes, which is about the time in which the 5,000 pounds of slag would have run in.

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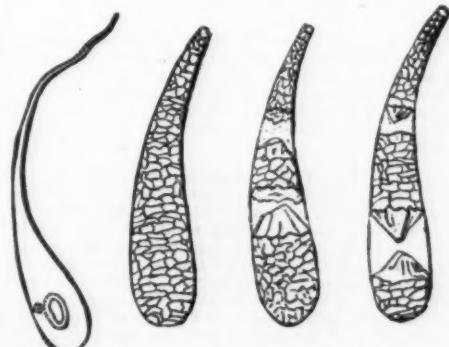


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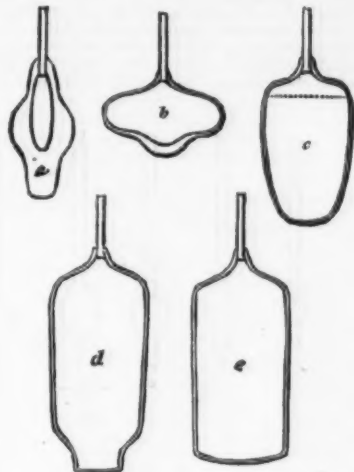


Fig. 4.—SHEET GLASS.

the ware in a heated oven or kiln, and allowing the source of heat to die out.

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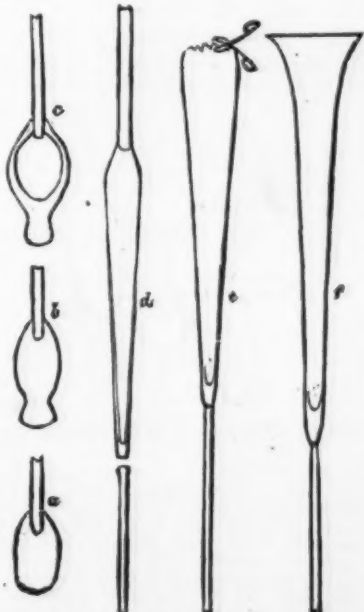


Fig. 5.—LONG VASE.

teristic colors of the oxides of gold, silver, copper, manganese, iron, and cobalt are, respectively, pink, yellow, peacock-blue, violet, dull green, and purple-blue. Copper and iron possess two oxides each, namely, a peroxide containing a large proportion of oxygen, and a sub-oxide containing a smaller proportion. The peroxide of copper gives a blue or

* A paper recently read before the Society of Arts.

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green color, and the sub oxide a ruby red. The peroxide of iron gives a yellow, and the sub-oxide a dull green. Certain oxides are valuable for their power of respectively increasing or diminishing the oxidation of other oxides. Thus, to obtain an iron yellow, which is the characteristic color of the peroxide of iron, it is necessary to add to the mixture oxide of manganese, which, at a high temperature, parts with its oxygen and its coloring power simultaneously. The oxygen thus set free goes to the assistance of the peroxide of iron, which has a tendency to part with its oxygen, and to produce a green color. The sub-oxide of copper has a great tendency to rob oxygen from any convenient source, and to produce a blue or green, instead of a red; it is therefore necessary, when a red is wanted, to mix with it some substance which absorbs oxygen with greater avidity. The oxide used for this purpose is the sub-oxide of tin. It often happens that in preparing the pink from the oxide of gold and red from the oxide of copper, the reductive action is carried too far, and instead of having the oxide in solution,

ever simple the tools may be, the variety of form which a blown bulb may be forced to assume is inexhaustible. The molten glass, when gathered from the crucible, is too fluid for immediate manipulation, and requires to be partly solidified by rolling on a polished iron slab, or by insertion in moistened wooden cup-shaped moulds, from which the glass may assume a rough outline of its ultimate form. The first process in every case is blowing through the hollow gathering iron until the mass of glass be expanded into a bulb. If the iron be held vertically, with the bulb downward, the bulb is elongated by gravitation, and expanded at the same time; if the bulb be raised and blowing be continued, it increases in circumference only. The bulb may also be elongated by gravitation alone, assisted by a swinging motion. While the bulb is being shaped with the spring tool, it must be kept in constant rotation by rolling the rod, to which it is attached upon the arms of the chair, as otherwise it would collapse. If the end of the bulb, remote from the blowing iron, be opened, and the bulb be rapidly rotated

care must be taken to develop the effects due to the natural properties of the material. The standard must be the highest possible, and no vessel should be allowed to leave the sorter's hands which is not perfect both in material and workmanship.

Effectual assistance in the competitive struggle may be derived from the adoption of improved methods of working and the application of improved knowledge and of greater economy throughout all the processes of manufacture. Above all, it will be advantageous if workmen and manufacturers can discover that their true interest is identical. The Flint Glass Makers' Society makes, and has made, mistakes; but these mistakes form no valid reason for antagonism, and to the society are due the increased sobriety, intelligence, and productive capacity of the workmen.

[Continued from SUPPLEMENT 294, page 4690.]

[MINING AND SCIENTIFIC PRESS.]

PHYSICAL STUDIES OF LAKE TAHOE.

By Prof. JOHN LE CONTE.

HAS PURE WATER ANY COLOR BY DIFFUSE REFLECTION?

In relation to the colors observed in the deep waters of certain lakes and seas, it is evident that the transmitted light cannot reach the eye of the observer. Hence it is plain that if such waters were perfectly free from all foreign materials, in solution or mechanically suspended, there are only two methods by which colored tints can emanate from the interior of such a transparent liquid. These are for pure water: 1. Color tints by diffuse selective reflection from the aqueous molecules; 2. Color tints produced by selective absorption and the diffuse reflection of the unabsorbed light. In the first case the tints of pure water would be analogous to those of opalescent liquids. In the second case the hues would be analogous to those of weak colored solutions, in which the colors by transmission and reflection are the same. In both cases it is absolutely essential, in order that the color tints should reach the eye of the observer floating on the surface of deep waters, that the aqueous molecules should possess the property of reflection; the only difference being that in the first case the reflection is selective, while in the second case all the unextinguished rays are more or less reflected. So that the primary question which is to be settled is: Whether perfectly pure water has any color by diffuse reflection of light from the interior of the liquid? This, being a question of fact, can only be settled by observation and experiment.

We have already seen that Sir I. Newton, and many of his successors, thought that water exercised a selective reflection on the rays of sunlight which traversed it. In proof of this he records an observation related to him by his distinguished contemporary and friend, Dr. Edmund Halley. Having descended under sea water many fathoms deep, in a diving bell, Halley found, in a clear sunshine day, a crimson color (like a damask rose) on the upper part of his hand, on which fell the solar rays after traversing the stratum of water above him and a glass aperture; whereas the water below him, and the under part of his hand, illuminated by light coming from the water beneath, appeared green. From which Newton concluded that the sea water reflects the violet and blue rays most easily, and allows the red rays to pass most freely and copiously to great depths. Hence the direct light of the sun must appear red at all great depths, and the greater the depth the fuller and more intense must the red be; and at such depths as the violet rays scarcely reach, the blue, green, and yellow rays, being reflected from below more copiously than the red ones, must make a green ("Newton's Optics," book 1, part II., prop. 10, exp. 17). At a later date, J. H. Hassenfratz verified Newton's explanation by means of a long tube blackened inside, closed at the ends by glasses and filled with pure water, through which the solar rays were made to pass. The transmitted light became successively white, yellow, orange, or red, as the length of the column of water traversed was augmented. Annular diaphragms placed at different points of the tube appeared black on the side of the observer at the point where the transmitted light was white, a feeble violet where it was yellow, blue where it was orange, and green where it was red. The diaphragms being illuminated by the ray reflected from the interior portions of the water, the light presented a color complementary to that which was transmitted.*

It is evident, therefore, that both Newton and Hassenfratz regarded pure water as possessing the properties of an opalescent medium. On the other hand, we have already shown that distilled water really absorbs the solar rays constituting the red end of the spectrum more copiously than those of the blue end, so that the transmitted light comes out greenish blue. The discrepancy thus indicated is doubtless due to the circumstance that in the older observations and experiments the water employed was not sufficiently free from mechanically suspended materials; for the presence of an extremely minute quantity of suspended matter in distilled water is sufficient to change the color of the transmitted solar light from greenish blue to yellow, orange, or red, according to the amount of foreign materials present. Thus Tyndall found that when an alcoholic solution of mastic and other resins is added to water, a finely divided precipitate is formed, which, when sufficiently diluted, gives the liquid a blue color by reflected light. Hence, he maintains "that, if a beam of white light be sent through a liquid which contains extremely minute particles in a state of suspension, the short waves are more copiously reflected by such particles than the long ones. Blue, for example, is more copiously reflected than red. When a long tube is filled with clear water the color of the liquid (blue-green), as before stated, shows itself by transmitted light. The effect is very interesting when a solution of mastic is permitted to drop into such a tube, and the fine precipitate to diffuse itself in the water. The blue-green of the liquid is first neutralized, and a yellow color shows itself; on adding more of the solution, the color passes from yellow to orange, and from orange to blood red." Again he says: "It is evident this change of color must necessarily exist, for the blue being partially withdrawn by more copious reflection, the transmitted light must partake more or less of the character of the complementary color" ("Glaciers of the Alps," "Colors of the Sky," edition cit. ante, pp. 259-261).

My own experiments, by means of the series of glass tubes

* The above account of Hassenfratz's experiments is taken from Daguin's "Traité de Physique," third edition, tome 4, article 3056, p. 417; Paris, 1868. Not being able to find any reference to Hassenfratz's original paper, I wrote to Prof. A. Daguin, of Toulouse, and ascertained that the details given in his treatise were taken from the grand "Encyclopédie Méthodique," 1816; "Dictionnaire de Physique," word *Couleur*, page 610. He further informs me that he has never seen the original memoir, and doubts whether it was ever published in extenso. The details given by Daguin are said, by him, to be scarcely less full than those given in the "Dictionnaire de Physique." I am not able to find a copy of the "Encyclopédie Méthodique" on this coast.

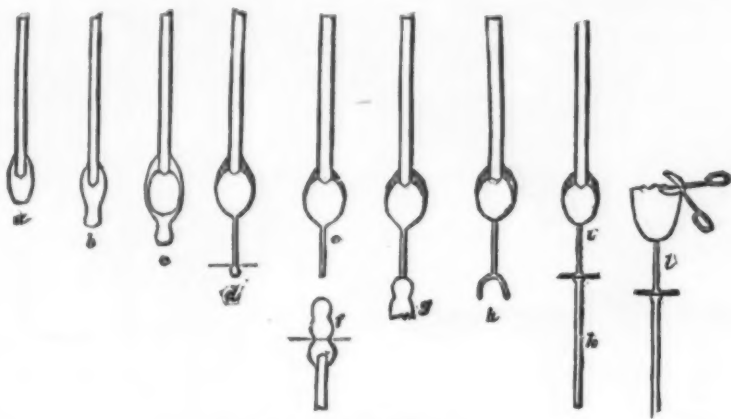


FIG. 6.—WINE-GLASS.

the metal is found suspended in the glass in a state of extremely fine division. The glass in this condition reflects a red color, but transmits an opalescent blue. If the particles of the metal be sufficiently large to reflect the characteristic color of the actual metal, the well known effect of aventurine is obtained. The different colors produced by the same oxide are best observed in the case of copper and cobalt. A small quantity of the peroxide of copper gives a blue, and a larger quantity a green. In the same way a strong dose of the oxide of cobalt gives a red, a smaller dose a violet, and a comparatively minute quantity the characteristic blue, or a thick layer of cobalt glass transmits red rays, a thinner layer, violet rays, and a still thinner one, blue rays.

Opacity may be produced by devitrification, by the semi fusion of pulverized white or colored glasses, and by the addition to transparent glass of some infusible material. Devitrification has never been pressed into practical use; the semi-fusion of pulverized glass places at the decorator's disposal a material of great strength, possessing a granular and irregular surface, together with the power of developing almost every tint of color in an absolutely permanent condition. The process is also valuable to the manufacturer, as supplying a means of utilizing waste. Opaque black glass or black enamel is formed by the addition to transparent glass of an excess of an infusible or partially fusible black oxide, as, for instance, that of iridium, of cobalt, of manganese, or of iron. White and colored enamels owe their opacity to the oxide of arsenic, the oxide of tin, the phosphate of calcium, or to cryolite, a compound of sodium, aluminum, and fluorine, and their colors to different metallic oxides. It is cryolite which gives the opacity to the well-known hot pressed porcelain, good specimens of which have been kindly lent by Mr. J. G. Sowerby, of Gateshead-on-Tyne.

II.—MANIPULATION.

The molten glass gathered on the end of the hollow blowing iron may be placed in a mould, and by the pressure of a



FIG. 7.—APPLICATION OF HANDLES, SCROLLS, &c.

workman's breath on its inner surface, may be forced to adapt both its internal and its external surface to the form and surface of its environment. By this means the glass may not only receive the actual form of the interior of the mould, but may also be imprinted by any depressed or raised ornament, wrought on its inner surface. If, instead of being expanded by the workman's breath, it be forced to adapt itself to the mould by the descent of a plunger, it will assume on its outer surface the internal form of the mould, together with any decoration which may be wrought upon it, and on its internal surface the form and surface of the plunger.

The molten glass may also be fashioned by the breath and the simple tools of the glassblower. The arms of the chair in which the workman sits, and the hollow and solid rods by which he holds and rotates the glass with his left hand, constitute the entire mechanism of his lathe. His principal tools are what may be called the sugar-tong spring tool, the shears, the battledoor or flattening tool, together with a variety of simple clips, measure sticks, and calipers. How-

and heated simultaneously, it will suddenly fly open by centrifugal force into a flattened disk. If the disk be reheated, and the iron held perpendicularly with the disk downward, the disk will gradually crumple and collapse. The heat required to renew the plasticity of glass essential to manipulation is obtained by inserting the bulb or vessel into the mouth of a heated crucible, or into a furnace adapted to the purpose. If to the end of a solid mass or hollow bulb of glass a second working rod be attached by a seal of glass, and the workman recedes while retaining the blowing iron, and an assistant recedes carrying the second rod, the bulb or mass which unites them may be indefinitely extended. If a connection be formed between a source of molten glass and the circumference of a heated wheel, and the wheel be caused to revolve with speed, a thread is coiled upon the wheel in an extreme state of tenuity. This thread may be spun into a decorative fabric.

III.—TREATMENT OF SURFACE IN ORDER TO SUPPLEMENT EFFECT DUE TO NATURE OR FORM.

Decorative surface obtained by blowing into moulds.

- Venetian sheet glass.
- Ribbed and diamond-moulded table glass.

Decorative applications to surface by heat.

1. Colored and metallic gems, seals, and frills.
2. Etchings in gold leaf.
3. Sections of variegated cane.
4. Threading, imitation leaves and feathers, and various forms of threading.
5. Reticulated enamel ornament, with bubbles.
6. Metallic, colored, and scale decoration.
7. Frosted glass.
8. Iridesence.

Decorative applications without heat.

1. Iridesence by corrosion and decay.
2. Cutting.
3. Engraving.
4. Sand blast process.
5. Acid.
6. Carving. Specimens lent by Mr. Thomas Webb, of Stourbridge Glass Works, Stourbridge. The origination of the process is due to Mr. Northwood.
7. Enamel painting and gilding, fixed by heat.
8. Mosaic transparent glass.
9. Mosaic opaque glass.
10. Stenciled opaque glass.

Such are a few of the processes now employed in the manufacture of glass for decorative purposes. Additional and improved processes will constantly be introduced as long as the demand for decorative glass continues. The style of the products of our flint glass manufactories has so completely changed in the course of a few years, that it is difficult to foresee upon what lines the manufacture of the future is likely to run. The change is clearly indicated by the fact that whereas flint glass was almost entirely sold by weight, sale by weight is at the present time an exception. This change indicates a loss of a staple product, namely, the heavy ware of medium or common quality. The majority of this ware is now produced on the Continent; the remainder has been retained in England by the perfection of the material of pressed glass, and of the mechanism by which it is produced. Pressing glass is a manufacture by itself, and the loss remains to the workmen and manufacturers of flint glass. Decorative glass has taken the place of that which has been lost, but it is doubtful how long it will be possible to produce it with profit, considering the increase of foreign competition. English flint glass manufactories are now mainly turning out the best quality of table glass and decorative glass, and their chief profit depends upon the invention of a succession of novelties. The only safeguard of these two branches of manufacture is to adopt an English style and an English standard. The style should be determined by consideration of the utility of the vessels produced, and of the nature of the material. It is, for instance, undesirable to expend prolonged labor upon the decoration of glass which is essentially fragile. The forms and decoration of the wares produced must be elegant and simple, and every

already described, strikingly confirm the foregoing deductions. Indeed, I was unable to find any natural waters, however clear, which did not contain a sufficient amount of finely-divided particles in a state of suspension to impart the opaline characters to the transmitted solar light.

The purest hydrant water, as well as the water taken from the Pacific Ocean in lat. 39° 17' north, and long. 123° 58' west from Greenwich, did not manifest the greenish-blue tint of distilled water by transmitted light, but exhibited colors of the emergent beam, which varied from yellowish orange to green according to the amount of suspended matter present in the column of liquid. As early as 1857, Prof Tyndall seems to have fully recognized the important function of finely divided suspended matter in imparting the blue tints to the light reaching the eye by diffuse reflection from the interior of masses of water. This is distinctly indicated in the account of his experiments already quoted. Again, in speaking of the bluish appearance of thin milk, he says: "Its blueness is not due to absorption, but to separation of the light by the particles suspended in the liquid." In reference to the blue color of the waters of the Lake of Geneva, on the 9th of July, 1857, he remarks: "It may be that the lake simply exhibits the color of pure water" ("Glaciers of the Alps," edition cit. ante, pp. 33, 34). But a little later, and after making the experiments previously noted, he very significantly asks: "Is it not probable that this action of finely divided matter may have some influence on the color of some of the Swiss lakes—on that of Geneva, for example?" Again, in speaking of the color of the water of this lake, he says: "It seems certainly worthy of examination whether such particles suspended in the water do not contribute to the production of that magnificent blue which has excited the admiration of all who have seen it under favorable conditions" (Op. cit. supra, p. 261). Nevertheless, it is quite evident that at this time Prof. Tyndall regarded the suspended particles as playing a comparatively secondary part in the production of the blue tints of the natural waters; for he clearly intimates that pure water has an inherently blue color in the same sense as a weak solution of indigo. It was not until twelve years later that the beautiful experimental investigations of Prof. Tyndall, in January, 1869, in relation to the blue color of the sky, the polarization of sky light, and on the polarization of light by cloudy matter generally ("Proceedings of Royal Society," vol. 17, No. 108, pp. 221-233, Jan. 14, 1859), first suggested to J. L. Soret, of Geneva, the analogy which exists in regard to polarization, between the light of the sky and the blue light coming from the water of the Lake of Geneva. In a letter addressed to Prof. Tyndall, dated Geneva March 31, 1869, M. Soret maintains that blue color of the water of this lake is due exclusively to the suspended solid particles, from the fact, which he establishes by direct experiments, that this light presents phenomena of polarization identical with those of the light of the sky. For his experiments show: 1st, that the plane of polarization is coincident with the plane of incidence; and 2d, that the polarization is a maximum when the light received by the eye is emitted at right angles to the direction of the reflected solar rays in the water (*Phil. Mag.*, 4th series, vol. 57, p. 345, May, 1869; also "Comptes Rendus," tome 63, p. 911, April 19, 1869; also "Archives des Sci. Phys. et Nat.," tome 25, p. 64, May, 1869).

During the year 1869, and soon after the publication of these investigations of the Swiss physicist, Alex. Lallemand made a number of interesting communications to the French Academy of Sciences on the "Illumination of Transparent Bodies," in which he attempted to controvert the deduction of Soret, and attributed the diffuse illumination of such media—as well as the peculiar phenomena of polarization above noticed—to the action of the molecules of water, and not to the presence of foreign corpuscles in suspension. The French physicist bases his conclusions mainly upon the phenomena manifested in transmitting beams of solar light through clear glass and distilled water, which he assumed to be optically homogeneous media. (For full text of Lallemand's memoirs vide "Ann. de Chim. et de Phys.," 4th series, tome 32, pp. 200-234, February, 1871; and "Ann. de Chim. et de Phys.," 5th series, tome 8, pp. 93-136, May, 1876.) But the views of Soret were very soon abundantly verified by additional and more refined experimental researches, by which it was proved that under the searching test of a concentrated beam of light traversing such media in a darkened room, none of them manifested anything approaching to absolute homogeneity in relation to light. Under the hypothesis that the illumination of such bodies is due exclusively to the presence of foreign corpuscles suspended in them, it is evident that the more a non-fluorescent liquid (as water) is deprived of heterogeneous particles, the less must be its power of diffuse illumination; and, if we could secure a complete elimination of the particles in suspension, a concentrated luminous beam would produce no laterally visible track in traversing the liquid. Accordingly, in relation to water, the experiments of Soret, in January and February, 1870, show that the most careful distillation does not entirely remove the suspended matter; although, in proportion to the care with which the distillation was made, the less was the light scattered in traversing the liquid. Moreover, he found that the scattering power of the waters of the Lake of Geneva was diminished by allowing the liquid to repose long enough (many months) to permit the suspended matter to partially subside. Conversely, the experiments of the same physicist prove conclusively that when the number of particles in suspension is augmented—provided they are sufficiently attenuated—the power of illumination in the water was considerably increased without modifying the phenomena of polarization. Thus, it was found that very diluted precipitates formed in distilled water gave rise to considerable augmentation in the power of diffuse illumination, and the light emitted transversely to the traversing luminous beam presented the same characters of polarization as have been previously indicated. For example, a flask filled with water from the Lake of Geneva, which, after long repose, manifested a very feeble power of illumination, when a drop of a solution of nitrate of silver was introduced, the presence of a trace of some of the chlorides gave rise to a delicate precipitate which was invisible in diffused light; but in a darkened room it exhibited a notable augmentation in the brightness of the track produced by the passage of a concentrated beam of solar light, and the phenomena of polarization were complete. The addition of a second drop of the solution of nitrate of silver augmented the power of illumination, the track of the beam appeared distinctly blue, and the polarization became more complete. ("Archives des Sci. Phys. et Nat.," tome 37, pp. 146-153, February, 1870.)

In like manner the experiments of Tyndall, in October, 1870, prove that while, as a general fact, the concentrated beam of light may be readily traced through masses of the purest ice when made to traverse them in various directions, yet there were remarkable variations in the intensity of the

scattered light, and in some places the "track of the beam wholly disappears." In relation to water, Tyndall was also unsuccessful in entirely removing the suspended particles by the most careful and repeated distillations. His experiments on water taken from the Lake of Geneva and from the Mediterranean Sea, off the coast of Nice, show that the concentrated beam of light traversing each of them manifested a distinct blue color when viewed laterally. "Viewed through a Nicol prism the light was found polarized, and the polarization along the perpendicular to the illuminating beam was a maximum." He adds: "In no respect could I discover that the blue of the water was different from that of the firmament." (*Nature*, vol. 2, pp. 489, 490, October 20, 1870.)

Professor Edward Hagenbach confirmed Soret's views in relation to the polarization of the blue light emanating from the waters of lakes, by a series of observations on the Lake of Lucerne.

Without contesting the fact that the polarization of the diffused light emitted from such waters is produced by reflection from minute particles held in suspension, he, nevertheless, suggests that a certain want of homogeneity, due to differences of temperature in the layers of water, might likewise give rise to similar phenomena of polarization. But Soret has shown, by direct experiments, that it is not possible to attribute the illumination and polarization to the reflections from the layers of water of unequal density; moreover, even if these reflections contribute something, in certain cases, to the production of the phenomena, it is evident that, under ordinary circumstances, their influence must be insignificant. ("Archives des Sci. Phys. et Nat.," tome 37, pp. 186, 187, February, 1870.) In the light of the results afforded by the preceding experimental investigations, we are now prepared to give a definite and intelligible answer to the question "whether perfectly pure water has any color by diffuse reflection of light from the interior of the liquid." It seems to me that the evidence leading to a negative answer to the foregoing question is overwhelming.

Professor Tyndall's conclusion in relation to this point appears to be a perfectly legitimate deduction from the ascertained facts. In speaking of the water obtained from the fusion of selected specimens of ice, in which extraordinary precautions were taken for excluding impurities, and which were regarded as the purest samples of the liquid hitherto attained, this sagacious physicist remarks: "Still I should hesitate to call the water absolutely pure. When the concentrated beam is sent through it the track of the beam is not invisible, but of most exquisitely delicate blue. This blue is purer than that of the sky, so that the matter which produces it must be finer than that of the sky. It may, and indeed has, been contended that this blue is scattered by the very molecules of the water, and not by the matter suspended in it. But when we remember that this perfection of blue is approached gradually through stages of less perfect blue, and when we consider that a blue in all respects similar is demonstrably obtained from particles mechanically suspended, we should hesitate, I think, to conclude that we have arrived here at the last stage of purification. The evidence, I think, points distinctly to the conclusion that could we push the process of purification still further, even this last delicate trace of blue would disappear." (Fragments of Science: "Dust and Disease," pp. 319-322, Am. Ed., N. Y., 1875.) In other terms, "water optically homogeneous would have transmitted the beam without revealing the track." "In such water the course of light would be no more seen than in optically pure air." Hence the scattering of the light is not molecular, but is evidently due to the presence of finely divided matter in a state of suspension, whereby the shorter rays of the beam are intercepted and diffused more copiously than the longer ones, thus rendering the track of the light visible in the liquid, and imparting a blue tint to the laterally scattered polarized light. The conclusion seems, therefore, to be inevitable that, if water were perfectly free from all foreign materials, either in solution or chemically suspended—both chemically and optically pure—it would have no color at all by diffusion of light; in fact, inasmuch as no scattered light would be emitted from the traversing beam, it would show the darkness of true transparency.*

CAUSE OF THE BLUE COLOR OF CERTAIN WATERS.

The preceding considerations very clearly indicate that the real cause of the blue tints of the waters of certain lakes and seas is to be traced to the presence of finely divided matter in a state of suspension in the liquid. We have seen that Sir I. Newton, and most of his successors as late as 1869, ascribed the blue color of certain deep waters to an inherent selective reflecting property of its molecules, by which they reflected the blue rays of light more copiously than the other rays of the solar spectrum. Since the researches of Soret, Tyndall, and others, this selective reflection has been transferred to the finely divided particles which are known to be held in suspension in greater or less abundance, not only in all natural waters, but even in the most carefully distilled water. When the depth of water is sufficiently great to preclude any solar rays reaching the bottom, then the various shades of blue which are perceived under similar conditions of sunshine will depend upon the attenuation and abundance of materials held in suspension; the purity and delicacy of the tint increasing with the smallness and the degree of diffusion of the suspended particles. Moreover, it is evident that Tyndall is quite correct in assigning to "true molecular absorption" some agency in augmenting "the intense and exceptional blueness" of certain waters; for it is obvious that the "blue of scattering by small particles" must be purified by the abstraction of the less refrangible rays, which always accompany the blue during the transmission of the scattered light to the observer. It seems to be very certain that were water perfectly free from suspended matter and coloring substances in solution, and of uniform density, it would scatter no light at all. "But," as Tyndall remarks, "an amount of impurity so infinitesimal as to be scarcely expressible in numbers, and the individual particles of which are so small as wholly to elude the microscope," may be revealed in an obvious and striking manner when examined by a powerfully concentrated beam of light in a darkened chamber. If the waters of the lakes and seas were chemically pure and optically homogeneous, absolute extinction of the traversing solar rays would be the consequence if they were deep enough. So that to an observer floating on the surface such waters would appear as "black as ink," and, apart from a slight glimmer of ordinary light reflected from the surface, no

light, and hence no color, would reach the eye from the body of the liquid. According to Tyndall, "in very clear and very deep sea water, this condition is approximately fulfilled, and hence the extraordinary darkness of such water." In some places, when looked down upon, the water "was of almost inky blackness—black qualified by a trace of indigo." But even this trace of indigo he ascribes to the small amount of suspended matter, which is never absent even in the purest natural water, throwing back to the eye a modicum of light before the traversing rays attain a depth necessary for absolute extinction. He adds: "An effect precisely similar occurs under the moraines of the Swiss glaciers. The ice is here exceptionally compact, and owing to the absence of the internal scattering common in bubbled ice the light plunges into the mass, is extinguished, and the perfectly clear ice presents an appearance of pitchy blackness" ("Hours of Exercise in the Alps"; "Voyage to Algeria to Observe the Eclipse," Am. Ed., N. Y., 1871, pp. 463-470). In like manner the waters of certain Welsh tarns, which are reputed to be bottomless, are said to present an inky hue. And it is more than probable that the waters of the Silver Spring, whose exceptional transparency has been previously indicated, would, if they were sufficiently deep, present a similar blackness, or absence of all color by diffuse reflection.

CAUSE OF THE GREEN COLOR OF CERTAIN WATERS.

It remains for us to explain the cause of the green tints which the waters of certain lakes and seas assume under peculiar circumstances. These green colors manifest themselves under the following conditions, viz.: (a) In the finest blue water, when the depth is so small as to allow the transmitted light to be reflected from a bottom which is more or less white. Thus, a white sandy bottom or white rocks beneath the surface of the Lake of Geneva, or the Bay of Naples, or of Lake Tahoe, will, if the depth is not too great or too small, impart a beautiful emerald green to the waters above them. (b) In the finest blue water, when a white object is looked at through the intervening stratum of water. In the blue waters of the sea this is frequently seen in looking at the white bellies of the porpoises, as they gambol about a ship or steamer. In a rough sea, the light which has traversed the crest of a wave and is reflected back to the eye of the observer from the white foam on the remote side, sometimes crowns it with a beautiful green cap. In March, 1869, I observed this phenomenon in the magnificent ultramarine waters of the Caribbean Sea. A stout white dinner plate, secured to a sounding line, presents various tints of green as it is let down into the blue water. Such experiments were made by Count Xavier de Maistre, in the Bay of Naples, in 1832; by Prof. Tyndall, in the Atlantic Ocean, in December, 1870; and by the writer in Lake Tahoe, in August and September, 1873. (c) In waters of all degrees of depth, when a greater amount of solid matter is held in suspension than is required to produce the blue color of the purer deep waters of lakes and seas. Thus Tyndall, in his "Voyage to Algeria to Observe the Eclipse," in December, 1870, collected 19 bottles of water from various places in the Atlantic Ocean between Gibraltar and Spithead. These specimens were taken from the sea at positions where its waters presented tints varying from deep indigo blue, through bright green to yellow green. After his return to England, he directed the concentrated beam from an electric lamp through the several specimens of water, and found that the blue waters indicated the presence of a small amount of suspended matter; the bright green a decidedly greater amount of suspended particles, and the yellow green was exceedingly thick with suspended corpuscles. He remarks: "My home observations, I think, clearly established the association of the green color of sea water with fine suspended matter, and the association of the ultramarine color, and more especially of the black indigo hue of sea water, with the comparative absence of such matter" ("Hours of Exercise in the Alps"; "Voyage to Algeria to Observe the Eclipse," Ed. cit. ante, pp. 464 et 467).

There is one feature which is common to all of the three above indicated conditions, under which the green color manifests itself in the waters of the lakes and seas, viz.: When a white or more or less light colored reflecting surface is seen through a stratum of intervening water of sufficient purity and thickness. Condition c is obviously included; for it is evident that a background of suspended particles may, under proper conditions, form such a reflecting surface.

Inasmuch as under these several conditions, more or less of the transmitted light is reflected back to the eye of the observer, it is evident that the rays which reach him carry with them the chromatic modifications due to the combined influence of the selective absorption of the water itself, and the selective reflection from the smaller suspended particles. Hence, the chromatic phenomena presented, being produced by the mingling of these rays in various proportions, must manifest complex combinations of tints, under varying circumstances relating to color of bottom, depth of water, and the amount and character of the suspended matter present. In the explanations of the green color of certain waters by the older physicists, we recognize the full appreciation of the influence of selective reflection in the production of the phenomena; but they seem to have overlooked the important effects of the molecular absorption. We have seen that Sir I. Newton regarded the green tints of sea-water as due to the more copious reflection of the violet, blue, and green rays, while those constituting the red end of the spectrum are allowed to penetrate to greater depths ("Optics," loc. cit. ante). Sir H. Davy ascribes it, in part, to the presence of iodine and bromine in the waters, imparting a yellow tint, which, mingled with the blue color from pure water, produced the sea-green ("Salmonia, Collected Works," vol. 9, p. 201). In like manner, Count Xavier de Maistre ascribed the green tints to the yellow light, which, penetrating the water and reaching the white bottom or other light-colored submerged objects, and being reflected and mixed with the blue which reaches the eye from all quarters, produces the green ("Bibl. Univ.," vol. 51, pp. 259-278, Nov. 1832; also *Am. J. Sci.*, first series, vol. 26, pp. 65-75, 1834*). On the other hand, after Bunsen, in 1847, had established that chemically pure water extinguished the rays of light constituting the red end of the solar spectrum more copiously than those of the blue extremity, so that the transmitted tints were more or less tinged with blue, some chemists were inclined to attribute the green color of certain waters to the presence of foreign coloring substances. Thus Bunsen himself explained the brown colors of many waters,

* Similarly, Arago has very ingeniously applied the same principles to the explanation of the varying colors of the waters of the ocean under different circumstances, showing that when calm it must be blue by the reflective light; but when ruffled, the waves, acting the part of prisms, refract to the eye some of the transmitted light from the interior, and it then appears green ("Comptes Rendus," tome 7, p. 219, July 28, 1839).

especially of the North-German inland lakes, as produced by an admixture of humus; but he considered the green tints of the Swiss lakes and silicious springs of Iceland as rising from the color of the yellowish bottom (vide loc. cit. ante, p. 44, *et seq.*). Similarly we find that Wittstein, in 1860, from chemical considerations, concluded that the green color derives its origin from organic admixtures, because the less organic substance a water contains the less does the color differ from blue; and with increase of organic substances the blue gradually passes into green, and ultimately into brown. This is likewise the view taken in 1862, by Beetz, for he insists that in all waters the observed color of the liquid is that of the transmitted light, and not, in any case, of the reflected light. Moreover, he maintains that Newton, De Maistre, Arago, and others, were mistaken in classifying water among those bodies which have a different color by transmitted light to that which they have by reflected light (loc. cit. ante).

We have already shown that if the waters were chemically pure and perfectly free from suspended particles, the red rays of the traversing solar light would be first absorbed and disappear, while the other colored rays pass to greater depths, one after the other being extinguished in their proper order, viz., red, orange, yellow, green, blue, and violet, until at last there is complete extinction of the light in the deeper mass of the liquid. But the presence of suspended particles causes a part of the traversing solar light to be reflected, and, according as this reflected light has come from various depths, so will the color vary. If, for example, the particles are large, or are abundant and freely reflect from a moderate depth, and prevent reflection from a greater depth, the color will be some shade of green.

When the water is shallow and a more or less light-colored bottom, or a submerged object reflects the transmitted light to the observer through the intervening stratum of liquid, it is evident that the chromatic tints presented must be due to the combined influence of the selective absorption of the water itself, and the selective reflection from the smaller suspended particles.

In other terms, under these conditions, the tints are produced by the mingling of the blue rays with the yellow, orange, or red; so that the resulting hues must generally be some shade of green. In short, all the facts established by modern investigations seem to converge and point to the admixture of the blue rays reflected from the smaller suspended particles with the yellow, orange, and red rays reflected from the grosser matters below, as the true physical cause of the green tints of such waters.

HARMONY OF VIEWS.

The establishment of the very important function of solid particles held in suspension in water, in producing chromatic modifications both in the scattered light and in the transmitted light, serves to reconcile and to harmonize the apparent discrepancies and contradictions in the views of physicists who have investigated the color of water.

We have already seen that Sir I. Newton and most of his successors, as late as 1847, regarded water as belonging to the opalescent class of liquids, in which the diffuse reflected light and the transmitted light present more or less complementary tints; the former partaking more of the colors constituting the blue end of the color spectrum, while the latter presented more of the hues belonging to the red extremity. On the contrary, the more recent and more accurate experiments render it quite certain that in distilled water the rays of the red end of the spectrum are more copiously absorbed than those of the blue extremity; so that the emergent transmitted tint is yellowish green or greenish blue. At first view, these results appear to be discordant and irreconcilable; but, it will be recollected, that while even the most carefully distilled water contains a sufficient amount of suspended matter, to scatter enough light, to render the track of the traversing concentrated solar beam visible, yet in this case, the selective reflection of the blue rays, due to the suspended particles, is not adequate to neutralize the selective molecular absorption of the rays toward the red end of the spectrum. Nevertheless, as has been previously shown, the addition of very minute quantities of diffused suspended matter confers on distilled water the dichroic properties of an opalescent liquid.

The presence of an exceedingly small amount of suspended solid corpuscles, by selectively reflecting the shorter waves of light, is sufficient to neutralize and overcome the selectively absorbent action of the molecules of water on the longer waves; and thus, to impart yellow, orange, or red tints to the transmitted beam. Moreover, it is very questionable whether any natural waters are sufficiently free from suspended matter to deprive them of these dichroic characteristics.

Under this aspect of the subject, the views of Newton, derived from the observations of Halley, those of Hassenfratz, deduced from his own experiments, as well as the explanations of the green tints of certain waters, given by De Maistre, Arago, and others, completely harmonize with the conclusions deducible from modern researches, provided the property of selective reflection is transferred from the aqueous molecules to the finely-divided particles held in suspension.

As a striking illustration of the slight causes which sometimes transform the purest water into an opalescent or dichromatic liquid, it may be interesting to detail one of my own experiences. On the 21st of Dec., 1878, the series of glass tubes employed in my experiments (as previously indicated), being filled with distilled water, the transmitted solar beam presented, when received upon a white screen in a darkened room, the usual yellowish-green tint of my winter observations. On the 24th of Dec., or after an interval of three days, during which all parts of the apparatus had remained *in situ*, I was much surprised to find that the transmitted solar beam was enfeebled, and presented an orange red color with no tinge of green. Puzzled to discover what could have produced so marked a change in the optical properties of the liquid, the "scientific use of the imagination" pictured the possible development of ultra-microscopic germs, infusoria, bacteria, *conferva*, etc. The next day (Dec. 25) the same phenomenon presented itself, when I called the attention of my assistant, Mr. August Harding, who had kindly prepared the arrangements of the tubes, to the anomalous change that had taken place in the color of the transmitted beam. He suggested that, as he had used alcohol in cleaning the glass plates closing the ends of the tubes, and as the plates were secured to corks by means of Canada balsam, the alcohol absorbed by the corks, being gradually diffused, dissolved some of the balsam, which solution, mingling with the water, might produce a fine resinous precipitate, which might stifle the transmitted beam and scatter the rays of shorter wave length, thus leaving the orange-red rays predominant in the emergent light. This view was speedily verified by a critical examination of the track of the trans-

ing beam. A sensible turbidity was visible, in the darkened room, at the extremities of the column of water adjacent to the corks securing the glass plates; and the light diffused latterly at these portions, when examined by Nicol's prism, was found to be distinctly polarized. The emergent beam, examined by the spectroscope, exhibited orange and red in full intensity; but the yellow and green were greatly diminished. Ten days later (Jan. 2, 1879) the solar beam traversing the same column of water emerged much brighter than on Christmas Day, and the tint was orange tinged with yellow and red. This long repose, caused, doubtless, some of the resinous precipitate to become more generally diffused, or to subside, and thus diminished the turbidity of the liquid. The recognition of the dichroism imparted to water by the presence of finely-divided particles in suspension, serves, likewise, to harmonize the conflicting views promulgated by physicists who have studied the chromatic phenomena presented by this liquid. Some claim that the rays of higher refrangibility are more copiously withdrawn by absorption; while others maintain that the rays of longer wave lengths are more absorbed. In many cases the chromatic tints ascribed to selective molecular absorption are unquestionably due to selective diffuse reflection from the ultra-microscopic corpuscles which are held in suspension (vide Jamin's "Cours de Physique," 3d ed., tome 3, p. 447, *et seq.*).

COLORS OF SKY AND WATER.

The consideration of the dichroic properties imparted by the presence of finely divided matter in a state of suspension, likewise harmonizes the views of the older physicists with the deductions from modern investigations. It was long ago insisted that there existed a complete analogy between the tints of the sky and those of the purest natural waters; indeed, that the causes of the blue color of the sky and the red tints of sunrise and sunset were identical with those of the pure natural waters under corresponding circumstances. In other terms, that, in both cases, the blue tints are due to reflection and the red to transmission. In relation to the sky, these have been long recognized as the true causes of its variable tints. Now we have shown that the light transmitted by a column of natural water is in reality "yellow, orange, or red, like the light of sunrise or sunset," while the light reflected from the attenuated suspended particles partakes of the various shades of blue, like the hues of the sky. Hence the analogy is completely verified upon the sure basis of experiment. Moreover, the thermotic researches of Prof. Tyndall and others seem to demonstrate that liquids which possess absorbing qualities for radiant heat preserve these properties in the gaseous or vaporous state. In other words, when a liquid assumes the vaporous state its power of absorbing heat rays follows it in its change of physical condition. Hence, it appears that the absorption of the thermal rays seems to depend upon the individual molecules of the compound, and not upon their state of aggregation; for the change into vapor does not alter their relative powers of absorption. This power asserts itself correspondingly in the liquid and in the gaseous state. Now, although we have as yet no direct experimental evidence in regard to the relative powers of absorption of various vapors for the different luminous rays, yet these thermotic results render it analogically probable that vapors carry with them the same relative absorbing powers for the different rays of light which their liquids enjoyed. Hence we may conclude that if the mixture of air and aqueous vapor constituting our atmosphere were perfectly free from suspended particles (ultra-microscopic globules of water no less than solid corpuscles), it would probably, like distilled water, absorb more copiously the rays forming the red end of the solar spectrum than those of the blue extremity, so that the green-blue tints would appear by transmitted light. But, as in the case of natural waters, the presence of finely-divided matter in a state of suspension in the atmosphere, by scattering the shorter waves of light, neutralizes and overcomes the effect of selective molecular absorption; so that, in reality, yellow, orange, and red are the tints transmitted at sunrise and sunset, while the light reflected from the attenuated suspended particles gives us the blue color of the sky. It thus appears to be in the highest degree probable that the dichromatic properties of the atmosphere are due to the same principal causes as those of the waters of lakes and seas.

CAUSE OF OTHER COLORS OF CERTAIN WATERS.

Besides the rich blue and green tints which we have been considering, the waters of lakes and seas, in some places, present various other hues. From the preceding discussion it is evident that the shades of color, presented to the observer, will depend upon several circumstances, viz.: (a) the presence of coloring matters in solution; (b) the color of the bottom; (c) the depth of the water, and (d) the amount and character of the suspended matters present. (a) There are certain natural waters which obviously derive their colors from the presence of coloring substances in solution. In most cases various organic matters seem to be coloring agents. Thus the waters of pools, ponds, and small lakes, as well as those of their tributaries, in certain level forest-clad regions, frequently exhibit various shades of brown, and sometimes present a rich cherry color when viewed in considerable masses. These tints, doubtless, arise from the diluted colored infusions produced by the percolation of the meteoric waters through decaying leaves and other organic substances. (b) The color of the bottom, when the water is sufficiently shallow to reflect back to the observer more or less of the transmitted light, must, evidently, modify the resultant tint presented to the eye. According as the bottom exhibits various shades of white, green, yellow, or red, the mingling of these tints with the blue reflected from the suspended particles in the intervening stratum of water, must give rise to various chromatic hues, from bluish-green to yellowish red.

There is much uncertainty in relation to the origin of the color-designation of the Red Sea; but it is by no means improbable that it arose from the abundance of red coral found in it, which imparts a reddish tint to the waters occupying the shallow portions. The waters of the Bay of Loango, on the western coast of tropical Africa, have been observed to be always strongly reddish, as if mixed with blood, and Captain Tuckey assures us that the bottom of this bay is very red.

(c) It is scarcely necessary to remark that as the tint of the light coming from the bottom to the observer is modified by the thickness of the intervening stratum of liquid—the color due to the mingling of it with the blue reflected from the suspended particles must depend, to some extent, upon the depth of water as well as the hue of the bottom. (d) Lastly, it is very obvious that the amount and character of the suspended matter existing in the water, must, more or less, modify the color presented to the observer. Near the mouths of rivers the sea exhibits tints evidently depending upon the color of the suspended materials discharged into it. Thus,

the Yellow Sea derives its name from the hue imparted to its waters by the large amount of yellow sediments discharged into it by the Hoang-Ho and Yang-tse-Kiang. Moreover, the variety of colors of the waters of the seas may, in many instances, be traced to myriads of living vegetable and animal organisms diffused in the liquid. The unfortunate Captain Tuckey, while navigating the sea on the western coast of tropical Africa, found that the waters began to grow white on entering the Gulf of Guinea, and in the vicinity of Prince's Island his vessel appeared to be moving in a sea of milk. He ascribed this white color of the water to the multitude of minute animals (many of them phosphorescent), diffused near the surface, which completely masked the natural tint of the liquid. In like manner, according to the observations of Captain Scoresby, the olive green waters of certain portions of the Arctic Seas owe their color to the presence of myriads of medusae and other animalcules.

RHYTHMICAL VARIATIONS OF LEVEL IN LAKES OR "SEICHES."

As might be expected, the waters of Lake Tahoe are subject to fluctuations of level depending upon the variable supplies furnished by its numerous affluents. In midwinter, when these streams are bound in icy fetters, the level falls; while in the months of May and June, when the snows of the amphitheater of mountain slopes are melting most rapidly, the level of the lake rises, and a maximum amount of water escapes through its outlet.

According to the observations of Capt. John McKinney, made at his residence on the western shore of this lake, the average seasonal fluctuation of level is about 0.61 of a meter, but in extreme seasons it sometimes amounts to 1.37 meters. The Lake of Geneva, in like manner, is liable to fluctuations of level amounting to from 1.95 to 2.60 meters, from the melting of Alpine snows. But besides these variations of level, due to the variable quantities of water discharged into them by their affluents, many lakes of moderate dimensions are liable to rhythmical oscillations of level of short duration which are, obviously, not produced by fluctuations in the supply of water. It is to this kind or species of variation of level that our attention will be directed in the sequel.

This interesting phenomenon was first recognized in the Lake of Geneva, but was subsequently found to be common to all Swiss lakes, as well as to those of Scotland. It is, therefore, a general phenomenon, which may be observed in all lakes of moderate dimensions. The inhabitants of the shores of the Lake of Geneva have long designated this rhythmical oscillation of the level of the water by the term "seiche," and this designation has been adopted by scientific writers.

These "seiches" were first signalized in the Lake of Geneva, in 1730, by Fatio de Duillier, who ascribes them to the checking of the flow of the waters of the Rhone on the shoal near Geneva by the force of the wind at midday. Addison and Jallabert, in 1743, supposed them to be caused by sudden increments in the discharge of the affluents due to the augmentation in the amount of snow melted after midday, or to the sudden increase in the flow of the Ayre checking the outflow of the water by the Rhone. Bertrand supposed that electrified clouds might locally attract and elevate the waters of the Lake, and thus produce oscillations of level. H. B. de Saussure, in 1799, attributed the phenomenon to rapid local variations of atmospheric pressure on different parts of the lake. J. P. E. Vaucher, in 1802 and 1804, adopted De Saussure's explanation, and confirmed it by many excellent observations. He, moreover, established that "seiches," more or less considerable, occur in all the Swiss lakes, and that they take place at all seasons of the year and at all hours of the day, but in general more frequently in spring and autumn.

As regards the cause of the phenomenon, Vaucher shows how rapid local alterations of atmospheric pressure would produce oscillations in the level of the lake, and compares them to the vibrations of a liquid in a recurved tube or siphon. Finally, Arago maintained that "seiches" may arise from various causes, and traced the analogy between them and certain remarkable oscillations of the sea, including those arising from earthquakes. But physical science is indebted to Prof. Forel, of Lausanne, for the most complete and exhaustive investigation in relation to the phenomenon of "seiches." This accomplished physicist began his researches in 1869, and has continued them up to the present time. He has been able to demonstrate that these rhythmical oscillations occur in nearly all of the Swiss lakes (he studied the phenomenon in nine of them), and that they follow in all cases the same general laws. Those of the Lake of Geneva have received the most elaborate and prolonged investigation.

In March, 1876, Forel established a self-registering tide-gauge (*limnimètre enregistreur*), on the western shore of this lake, at Morges; and with the co-operation of P. Plantamour another one was installed in June, 1877, at Secheron, near the city of Geneva, at the southern extremity. Since these dates these two instruments have, respectively, been registering the oscillations of the level of the water of the Lake of Geneva and they are so sensitive as to indicate the waves generated by a steamer navigating the lake at a distance of ten or fifteen kilometers.

From a most searching investigation of all of the phenomena presented by the "seiches" in the Swiss lakes, Forel deduces the conclusion that they are really movements of steady unimodal oscillation "balanced undulations," in which the whole mass of water in the lake rhythmically swings from shore to shore. And, moreover, he shows that the water oscillates according to the two principal dimensions of the lake, thus giving rise to longitudinal "seiches" and transverse "seiches." They occur in series of tachronous oscillations of decreasing amplitude, the first wave produced by the action of a given cause having a maximum amplitude.

AMPLITUDE OF OSCILLATIONS.

The amplitude of the oscillations constituting the "seiches" is extremely variable. This, doubtless, arises from the fact that the causes producing the disturbances of hydrostatic equilibrium are extremely unequal in intensity and variable in kind. In some exceptional cases the amplitude of the oscillations has been very large; thus, there are on record the following extreme fluctuations of the level of the lake at Geneva:

Observed by Fatio de Duillier, in September, 1600, 1.624 meters; observed by De Saussure, August, 1760, 1.481 meters; observed by Venie, October, 1841, 2.138 meters.

By amplitude is meant the difference in height between the maximum and minimum level of the water in a complete rise and fall. Thus, in Venie's observation, the water rose 2.138 meters above the mean level of the day, and subsequently fell 0.920 meter below the same level, making the

amplitude 2.138 meters. Hence, we may say that the extreme amplitude of the "seiches" at Geneva fluctuates between 0 and 2.14 meters. In ordinary "seiches," however, it varies from 0 to 30 centimeters, or from 0 to 11.81 English inches. At Morges the self-registering instrument indicated amplitudes within the limits of 12.5 centimeters, and 0 and 4.93 inches.

DURATION OF OSCILLATIONS.

Like the rhythmical oscillations of a liquid in a siphon, the duration or time of vibration of any series of "seiches" at any given place and originating from a given cause is independent of the amplitude of the oscillations. In other terms the time of vibration is approximately the same whether the fluctuation of level be large or small. But the investigations of Forel clearly prove that the duration of the "seiches" depends upon the dimensions of the lake and upon the mean depth of the water along the axis of oscillation. Thus, in a long lake the time of oscillation of a longitudinal "seiche" will be longer than that of a transverse "seiche;" while on the other hand in a deep lake the duration will be shorter than in a shallow one. Hence, it follows that every lake has its own period of oscillation for both its longitudinal and transverse "seiches."

The disturbances of hydrostatic equilibrium which generate "seiches" may be produced by a variety of causes. Among these the following may be cited:

- Sudden local variations of atmospheric pressure on different parts of the lake.
- A descending wind striking the surface of the lake over a limited area.
- Thunder storms, hail storms, and water spouts, especially when the accompanying winds act vertically.
- The fall of a large avalanche or of a land slide into the lake.
- And lastly, earthquakes.

Observations show that the most frequent and evident of these causes are variations of atmospheric pressure and local storms. With regard to earthquake shocks as a cause of such fluctuations of level, it is a singular and significant fact, that since Forel has established the delicate self-registering apparatus on the shores of Lake Geneva, no less than twelve earthquake shocks have been experienced in this portion of Switzerland, and they have had no sensible influence on these sensitive instruments. In fact, a little consideration in relation to the character of such shocks renders it highly improbable that such brief tremors of the earth's crust could have any agency in the generation of rhythmical oscillations of the whole mass of water in the lake. Indeed, it is very questionable whether any earthquake waves are ever produced in the ocean, except when the sea bottom undergoes a permanent vertical displacement.

FORMULA FOR TIME OF OSCILLATION OF SEICHES.

The researches of Forel seem to prove that "seiches" belong to that class of water-waves in which the wave length bears a large ratio to the mean depth of the water.

The mathematical investigations of Sir G. B. Airy, and other physicists, show that, under these conditions, the time of one semi-oscillation of such a wave is given by the formula, $t = \pi \sqrt{d/g}$, in which,

- t = Time of semi-oscillation of the "seiche."
- d = Length or breadth of lake according as the "seiche" is longitudinal or transverse.
- d = Mean depth of lake, along direction of oscillation.
- g = Acceleration due to force of gravity.

The preceding formula shows that the duration of "seiches" is directly proportional to the length of the lake, and inversely proportional to the square root of its mean depth. Forel has shown that the results obtained by this formula accord approximately with the observations of "seiches" in Swiss lakes.*

LAKE TAOHO.

From inquiries made of the inhabitants of the shores of Lake Tahoe, I was not able to discover that any rhythmical oscillations of the level of its waters have been noticed. Some residents declared that they had observed sudden fluctuations of level, which, from their suddenness, they were disposed to ascribe to disturbances of the bottom of the lake due to volcanic agencies; although they were unable to co-ordinate such oscillations with any earthquake manifestations on the adjacent shores. It is evident, however, that until arrangements are consummated for recording systematic observations on the variations of the level of this lake, we cannot expect that its "seiches" will be detected. Of course, self-registering gauges would give the most satisfactory results; but any graduated gauge systematically observed would soon furnish evidence of the phenomenon. For the longitudinal "seiches," "Hot Springs," at the northern extremity of the lake, or "Lake House," at the southern end, would be eligible stations for gauges; and for the transverse "seiches," Glenbrook, on the eastern shore, or Capt. McKinney's, on the western margin, would afford good stations. As far as I am aware, "seiches" have never been observed in any of the American lakes. This fact is the more remarkable from the circumstance, that long-continued and careful observations have been made on the fluctuations of the level of several of the large Canadian lakes, with the view of testing the possible existence of lunar tides. Perhaps these lakes may be too large to manifest the unimodal rhythmical oscillations which have been so successfully studied by Forel in the smaller lakes of Switzerland. Be this as it may, there can be no doubt that Lake Tahoe is a body of water, in all respects, adapted for the manifestation of this species of oscillation, and that, like the Swiss lakes, it is subject to "seiches." Indeed, the far greater simplicity in the configuration of the basin of Lake Tahoe than that of the Lake of Geneva must render the phenomena much less complicated in the former than in the latter.

In advance of any observations it may be interesting to put on record the probable duration or period of oscillation of the "seiches" of Lake Tahoe. Such theoretical predictions or anticipations may be verified or disproved by future observations, and in order to apply such tests, it is convenient to have numerical results presented to the observer. In the formula, previously given, expressing the time of one semi-oscillation of the "seiche," all the factors can be readily determined in relation to Lake Tahoe, ex-

cepting the mean depth or (d). For this lake we have the quantities indicated in the formula, as below:

- Longitudinal = 21.5 English miles = 34,600 meters.
- Transverse = 13 English miles = 19,313 meters.
- At latitude 39° and 1,904 meters above sea-level = 9,794,808 meters per second.

The following table has been calculated by means of the formula, by assuming the several mean depths indicated in the table. The duration of one complete oscillation ($2t$) is given in the table instead of the value of one semi-oscillation (t) for both longitudinal and transverse "seiches" in Lake Tahoe.

LONGITUDINAL SEICHES.			TRANSVERSE SEICHES.		
D. in Meters.	2 T. in Seconds.	2 T. in Minutes.	D. in Meters.	2 T. in Seconds.	2 T. in Minutes.
450	1042	17.4	450	582	9.7
435	1073	17.9	435	599	10.0
400	1106	18.4	400	617	10.3
375	1142	19.0	375	637	10.6
350	1182	19.7	350	660	11.0
325	1226	20.4	325	685	11.4
300	1277	21.3	300	713	11.9
275	1333	22.2	275	744	12.4
250	1398	23.3	250	781	13.0
225	1474	24.6	225	823	13.7
200	1563	26.1	200	873	14.5
175	1671	27.9	175	938	15.5
150	1805	30.1	150	1008	16.8
125	1978	33.0	125	1104	18.4
100	2311	38.5	100	1234	20.6

From the soundings executed by me along the greatest axis of this lake (nearly north and south), the mean depth of water along this dimension cannot be much less than 400 meters; this would make the time of one complete longitudinal "seiche" about eighteen or twenty minutes. The mean depth along the transverse dimension is probably considerably smaller, perhaps about 250 meters; this would make the time of one complete transverse "seiche" about thirteen minutes. As soon as the duration of these rhythmical oscillations has been accurately determined by observations, the problem may be reversed; for the time being known, the same formula may be used for finding the mean depth of the lake along its two principal diameters.

THE ILLUSIONS OF TOUCH.

ONE of our readers has recently put us in mind of an experiment which is represented in the annexed figure, and which every one has been acquainted with from his school-boy days. The second finger is crossed over the index,



ILLUSIONS OF TOUCH.

and, with the two fingers in this position, a pen or marble is rolled about on a table or in the palm of the other hand. The sensation experienced is precisely the same as if two separate balls were being touched. Although, as we have said, this experiment is well known, we believe that the true explanation of the illusion of touch is not generally understood. A learned professor of sciences has recently given us this in concise form, which we here reproduce.

In the normal position of the fingers the same ball cannot touch at the same time the exterior sides of two contiguous fingers. When the two fingers are crossed the normal conditions are exceptionally changed, but the instinctive interpretation remains the same, unless a frequent repetition of the experiment has overcome the effect of our first education on this point. The experiment, in fact, has to be repeated a great number of times to make the illusion become less and less appreciable.

It is easy to perceive that in the domain of the sense of touch the judgment, being formed instinctively, finds itself at fault when the normal conditions are modified; thus it happens, for example, when we have on the lips an accidental pimple or swelling, the glass from which we drink appears to have a distorted edge. Facts of this nature are very interesting to study from a philosophical point of view, for they demonstrate that the judgment which we form in regard to external material realities is based upon the interpretation of our sensible impressions. The impression of our senses is something entirely physical, and in no wise psychological. Interpretation is an affair of habit and education.—From *La Nature*.

ON A SIMPLE DEVICE FOR PROJECTING VIBRATIONS OF A LIQUID FILM WITHOUT A LENS.

By H. S. CARHART, of Evanston, Ill.*

SEDLAY TAYLOR's phonoscopes, for obtaining vibrations in a liquid film, employs a horizontal film, and conveys the vibrations to an inclosed mass of air by means of a rubber tube and a funnel. In this case the figures obtained are viewed directly without projection.

Before the publication of Mr. Taylor's method in *Nature*, March 28, 1878, I had already succeeded in obtaining projections of such sound-figures by means of the lantern. A tin tube, five centimeters in diameter, was closed at one end with parchment, and at the other with a film of soapy water strengthened with glycerine. This film was held obliquely in the light in front of the lantern condenser; a lens in the path of the reflected beam formed an image of the film crossed with colored bands. The vibrations of the voice, taken up by the parchment, are communicated to the inclosed air and thence to the film. This method possesses the very important advantage of not disturbing the film with the breath, as in the case of a tube open next to the mouth.

Accident led to a simplification of this method when sunlight is used. The simplest apparatus that will effect the desired object is most serviceable in illustrating science. I do not hesitate, therefore, to present this very simple instrument, designed to project on a screen by means of sunlight, the sound-figures in a liquid film produced either by the voice or by an organ-pipe. No lens or mirror is employed, the film being made to project an image of itself. With sunlight directed horizontally into a window by means of a porte-lumière, the instrument contains in itself all that is necessary for projection.

A short, thick tube of wood is furnished at one end with a telephone mouth piece and ferretout plate; the other end has attached to it a funnel about ten centimeters in diameter; blackened within and without. Near the middle of the tube a stop-cock is inserted. A film is obtained in the open funnel in the usual way, and is then slightly distended by blowing air into the inclosure through the stop-cock. The stop-cock being closed, the apparatus is air-tight, and the film retains a nearly constant curvature. This convex film, held in the beam of light at the proper angle, causes the reflected rays to diverge and produces a greatly enlarged image of itself on the screen. The degree of magnification is completely under control, since it is dependent on the curvature of the film. If the curvature has been made too great, the contractile power of the film, due to its surface tension, may be made to expel some of the inclosed air through the open stop-cock.

Upon singing a sustained note at the mouth-piece, concentric circles, distorted into ellipses by oblique projection, appear upon the screen. These can be kept sufficiently steady to permit of photographing them. Two photographic negatives were taken from the screen on which the projections were made. One of them exhibits clearly what I have not been able to make out on the screen, viz.: a division of the film into segments with indistinct nodal lines radiating from the center, like the nodal lines on a circular plate of glass clamped at its center.

By placing a cap provided with a rubber band, and having a square opening made in it, into the open end of the funnel, a film of different shape is obtained. It is then observable that only notes of a definite pitch at the mouth-piece agitate this film in a well-defined manner; that is, produce in it "stationary waves." When a definite configuration is obtained, it is found to consist of a reticulated pattern of lozenge-shaped figures. Bright points are noticeable at every other intersection of the lines, appearing like knots tied in the interlaced cords of a net. Organ pipes produce these figures with more certainty and definiteness than the voice.

With a triangular opening in the cap, the distended film is too much distorted from the spherical form to yield a clear image. In this case, with a flat film a lens may be employed to obtain the image. Let a clear musical note then be sung near the mouth-piece of the apparatus; immediately the field of color is covered with an exquisite pattern of fixed, hexagonal figures, the colors presenting at the same time the appearance of flowing, sometimes irregularly and sometimes around fixed centers. With a clear, sustained note, nothing can exceed the beauty of this combined acoustic and chromatic display.

AERONAUTICAL SOCIETY OF GREAT BRITAIN.

THE annual general meeting of this society was held at the Society of Arts' room, July 11. The chair was taken by Mr. James Glaisher, F.R.S., who remarked that he regretted he could not speak of more important results. Mr. Infield, who had made a large shield a year since, had constantly been at work on it ever since, but was not satisfied with its present condition, and, therefore, reserved its exhibition for another occasion. He had hoped to have told them that balloons had been used for photographing the country, especially as the plates could now be prepared weeks beforehand, need only be exposed for a few seconds, and could be kept for a lengthened period before development; but these anticipations yet remained unfulfilled.

Mr. W. H. Phillips showed a model of a new flying-machine he was making, and read a paper describing it. He said the requirements for artificial flight were (1) that the expanse of wing-surface should be sufficient to sustain the whole weight in easy descent; (2) that the wing-surface needed might be provided by two large wings, or by many smaller wings equal thereto; (3) that lightness and strength were indispensable; (4) that the down-stroke of wing must be sufficient in force to sustain and propel horizontally the whole weight; and (5) the down-stroke, if intermittent, must be rapid, as otherwise the whole apparatus descends between the intervals of stroke. Acting on these principles, he had projected an apparatus which he had made to considerable size, employing an impetus of thirteen million pounds of steam. Of it he showed a model, consisting of an elementary skeleton in rigid steel wire for one long, slightly curved, and narrow wing; the frame was clothed with a series of loose cambric "feathers," oblong in form, hung from the ridge transversely. The whole weighed 4 oz., but required a weight of 4 lb. to move it up or down. However, by counterpoising the wing with another, it could be more easily moved, and he proposed to increase the number of these wings and to employ steam power for levitation.

The Secretary (Mr. F. W. Brearey) read a communication from Mr. S. E. Peal, of Sapokati, Silsagar, Assam, on "The Flotation of Large Birds and Balloons." It did not seem to be understood in England that large birds could not only

* "Proceedings of the American Association for the Advancement of Science," Boston Meeting, August, 1880.

* Forel's monographs on "seiches" of the Swiss lakes may be found in the several volumes of the "Archives des Sci. Phys. et Nat." from 1874 to 1880. We cite the following: Tome 49, p. 21 et seq.; tome 53, p. 281 et seq.; tome 57, p. 275 et seq.; tome 59, p. 60 et seq.; tome 63, pp. 113 et 120 et seq.

float without flapping the wings for long periods without coming down, but actually rise thus to elevations of some 1,000 to 6,000 or 8,000 ft. The bird, when thus soaring, seemed perfectly motionless, and could easily be followed and watched by a good telescope; in all cases the wings were fully extended rigidly. The pelican, adjutant, cyrus, and vulture all soared in this way. They invariably rose from the ground by flapping the wings vigorously; they did not soar or float in a calm, wind being needful; generally by rising they described a circular spiral track, a track which in the main seemed to tend to leeward. They had in Assam two steady winds, the N. N. E. and W. S. W., often blowing at once, one over the other alternating; birds would go some way in one and gradually return in the other. The birds were never seen to move in right lines for any distance, unless coming down. It was highly probable that the birds slept or dozed when soaring, and collision was not likely because of the loud vibration of the feather-tips. The solution of the question of soaring seemed of value, as it involved a minimum of muscular exertion, say one-tenth that of flying. The difference appeared to be that in flying, not only the friction of passage horizontally through the air had to be overcome, but the power needed to overcome gravitation; whereas, in soaring, which generally took place at high speeds, the winged-surfaces passed through the air and over a stratum of it ere the latter could be set in motion, as if it were rigid sheet-glass, on which the wings skated *à la* boomerang. Thus the usual effects of gravitation were not seen, and birds that soared needed long narrow wings, while those that only flew had shorter and wider wings. The wing surface narrowing as speed increased, would seem to indicate a useful direction to work in, the same applying to any form of screw for aerial propulsion. The support was also apparently more effective at or near the tips than close to the body, due, perhaps, to passing through a less disturbed state.

TATTOOING.

THE accompanying engraving, taken from our French contemporary, *La Nature*, represents a tattooed young male Japanese domestic. The tattooing is done in several colors, and produces exactly the appearance of a garment. We know a lady who lived a long time at Yokohama, says Mr. Tissandier,

dier, and she informs us that the servants employed about the dwellings of that city have no other costume than their tattoo and a simple pair of drawers; but, notwithstanding this, the medley of colors in the skin takes away all appearance of nudity.

Tattooing is practiced to a greater extent in the world than one might suppose. Mr. Magitot has endeavored to give the geographical distribution of its principal forms, and a résumé of his labor was published a few months ago in one of the excellent scientific reviews published by the *République Française* under the direction of Prof. Paul Bert. We reproduce herewith the most interesting details that Mr. Magitot has given.

In its simplest forms, tattooing exists, so to speak, everywhere. As well known, it is not rare to meet, even in our Western countries, men, and women too, who carry on the arms or breast designs traced in the skin. Its practice here usually consists in burning gunpowder on small incisions which penetrate beneath the epidermis. The object of doing this would be difficult to determine. Men who practice it appear to regard it as an ornament and almost as a proof of virility and a mark of distinction. Taking a broad view of it, as practiced among peoples generally, it is seen to have the same character and significance as other mutilations. Mr. Letourneau recalls the case of a Hawaiian who tattooed himself as a mark of respect and sorrow for the death of his king. But among peoples who go naked it serves, more than any other mutilation, as an ornament. Man began to ornament his body by painting it in different colors, just as savage or barbarous peoples do still. And perhaps, also, it was by the simple application of different colors to his skin that his tribe and rank were determined. The tribes along the Amazon are still distinguished by the colored marks that they make on their lips and body. Large numbers of tribes became possessed of the idea of making punctures for the introduction of coloring matter derived from the juice of plants, and of making these marks indelible. Tattooing by puncturing is also the most widely spread method, being met with in all parts of the world, from New Zealand up to among the Toongos Tartars, and is especially found in its most perfect forms in Polynesia and Malaisia. But in Polynesia, particularly, the tribes do not confine themselves to simple punctures; for they apply to the skin a design cut out of a leaf or a piece of bark, and follow its contours with a bone knife of special form, cutting the skin and staunching

the flow of blood as they do so. They do not always content themselves, after incisions, with introducing coloring matters, but often insert corrosive plants designed to make the wound puff up. This is practiced especially in the Fiji Islands, in the Marquesas, and in New Zealand. It is well known, especially, that Maori warriors carry on their faces tattooing in relief, the result of a very painful operation. The designs, which are often very well executed, become complicated in order to indicate rank, family, and exploits. Among the Australians a few new designs are added at every solemn period of life. The Tchoukchis, of Eastern Siberia, who go completely clothed, confine themselves to making deep incisions as reminders of their prowess in fishing, hunting, or war.

Those who have seen men completely tattooed know, as we have before remarked, that tattooing takes the place of clothing, for it entirely removes the impression of nakedness. It is, besides, highly ornamental. The Polynesians have a great passion for this style of skin decoration, and cover their bodies with graceful arabesques, circles, and lines. This passion, however, costs them dearly sometimes, for all do not support the operation equally well, and occasionally some lose their health thereafter and die. The Indians of North America are not much given to tattooing, and most of them regard it as a sort of infamous mutilation. The Nam Niams and the women of Hammedj, Motambé, Makondé, Mangandja, and Mackinga ornament themselves with garlands that are quite elegant. The Boris paint themselves with pipe-clay, the Bertas with red ochre, and the Monbuttos with red wood or with the black juice of *Gardenia*. But in general they confine themselves to pretty clumsy incisions and punctures. Large numbers of other African tribes practice tattooing, but to enumerate them all and to explain the method adopted by each would require us to extend this article to too great a length.

ARROW WOUNDS.*

By H. S. KILBOURNE, M.D., Captain and Asst. Surgeon, U. S. A.

THERE are, gentlemen, some peculiar features of military surgery, one of which I will take up briefly for your entertainment this evening. I say for your entertainment, because the special feature of which I now speak will be, to you, more curious than practical. It is characteristic of a people and period now changing.

It belongs, almost exclusively, to military surgery, and is, even now, a subject with which many military surgeons are unfamiliar.

It is one not treated of in systematic works on surgery. In many of these it is not mentioned. Its literature belongs mostly to the historical period, before the days of gunpowder. I allude to arrow wounds.

You, whose hearts have been touched by Greek fires, may remember that of all the heroes at the siege of Troy, whose wounds and deaths in battle are chronicled by the past, many are killed by arrows; and of these, scarcely two are struck in the same place or die in the same way.

The godlike Achilles, in order to become invulnerable, was plunged by his goddess mother into the river Styx. But as she held him by the heel, that part only was not bathed by the Stygian flood. There, finally, the arrow shot by Paris found entrance. Hippocrates, in his numerous campaigns, invented or used an instrument for the extraction of arrows and darts, called *belulerum*—a rude forceps for seizing and removing rude missiles from wounds.

As arrows were among the first offensive weapons used by man in ancient and barbaric times, so they are still the favorite weapon of many savage tribes. This antique weapon is, however, being rapidly displaced by rifles among those tribes whose enmities with the whites have taught them its superiority. An American Indian of the plains, who has seen a breech-loader and does not possess one, will part with all he has in the world to procure it. The bow and arrow is, therefore, disappearing, and with them the surgery of arrow wounds will become only a curious history.

The service bow of the Indian is quite a different thing from the dainty affair of the archery clubs. It is short, thick, and strong. It is made among the southwestern tribes of the bois d'arc or Osage orange. The string is of raw hide, or buffalo sinew. The arrow is made of pecan or any suitable wood, not too heavy, and having a straight, tough fiber. The arrow head, formerly of flint, is now usually made of soft iron, cut by a file into triangular shape. It is let into the split end of the shaft by a short shank, and fastened by wrapping with strips of sinew, put on before it is dry.

In hunting and fighting, the warrior is mounted on a swift and active pony, and in using the bow he comes to close quarters. In action he rides at full speed, slipping over to the side of the horse and discharging the arrows from: under the neck of the animal. The horse thus acts as a living shield for his body.

The rapidity, force, and precision of the shots are, in some instances, marvelous. As a rule, however, the accuracy is about that of a fair marksman with the pistol, as at a running mark.

There is in the Army Medical Museum, at Washington, a preparation of a portion of the left scapula of a buffalo, with an arrow head impacted in it. The barbed iron head of the arrow has entered the venter and the point protrudes from the dorsum, so that the missile must have passed through the thorax.

The specimen is from a buffalo killed at Fort Sedgwick, in 1860, by a Cheyenne Indian. There are also other specimens of bones, penetrated, perforated, and fissured in various ways, some of them resembling the appearance of glass through which a pistol ball has been fired a few yards off. The rapidity of the discharge of arrows rivals the fire of the best breech-loader I know of. The precision is sufficient to make it exceedingly uncomfortable for any one in the vicinity.

As the arrow head is secured to the shaft by strips of dried sinew, the wounds inflicted by it have this peculiarity: that in penetrating wounds, the fastening is softened by the fluids of the body, and when not at once extracted, the head becomes loosened and is detached when extraction is attempted.

In such cases it remains as a foreign body in the wound. If bone has been penetrated, the arrow head is impacted in it and held fast by the compact tissue, when extraction may become a difficult and hazardous operation.

The late Gen. Kearney suffered from a penetrating arrow

* Extract from an address read before the Buffalo Medical Club at its annual meeting, May 11, 1881.

† Dr. Otis, U. S. A., in Circular No. 3, S. G. O.

‡ Dr. Otis, U. S. A., in Report in Surg. Cases in the Army.



JAPANESE TATTOOING.

wound of the superior maxillary bone, received in an affray with hostile Indians about 1855 or 1856, until his death. The arrow head was so pinched and twisted by the hard bone, and attempts at removal were attended by such copious hemorrhage, that the iron was allowed to remain until a secondary operation was practicable. The missile was finally removed in St. Louis, after a severe operation, but the patient never entirely recovered from its effects. At short range, the arrow will perforate a flat bone, as a rib, making a clean cut, or a slight cracking or splitting. There is seldom any comminution or extensive fissuring like that produced by the impact of a conoidal rifle ball with bone.

In all the specimens showing penetration of the cranium, there is, according to Dr. Otis, little or no fissuring internally or externally. The inner and outer tables are both cleanly divided. This feature distinguishes arrow wounds of the calvaria from all others caused by weapons used in civilized warfare. Indeed, among all weapons I have seen, I know of none capable of making wounds so peculiar.

There are in the Army Museum specimens illustrating these features and also the impact of arrow heads.

For the relief of these injuries, it is most natural to seize the arrow and draw it out of the wound. But that will never do. The head will part with the shaft and remain in the bottom of the wound.

If not loosened by softening of the sinew, the head, if barbed, will catch in the soft parts, and may, in certain regions, work irreparable injury.

Dr. Bill, of the army, has employed a device for these operations which is often of great service. He passes the loop of a wire snare down along the shaft and over the arrow head, and when in place, secures it by traction on the outer end of the loop. The missile may then be carefully withdrawn entire.

When the iron is impacted in the bone, he employs a loop of annealed wire, passed down along the shaft, which serves as a guide. The arrow head is snared by the loop, the ends of the wire are then passed through a long suture twister, or double canula, which is passed down to the loop; the ends of the wire are then twisted or secured to the handle, and arrow and instrument are withdrawn together.

In a case where a Navajo arrow had penetrated the lung to a depth of five inches, Dr. Bill removed it by means of the simple snare first described.

A prominent army officer, now retired from active service, when serving in Texas as a subaltern, was, while in an encounter with hostile Camanches, transfixing by an arrow.

The weapon pierced the upper part of the right chest and passed nearly horizontally through the lung, the point protruding at the back, between the scapula and spine, on the same side. He informed me that at his own request a silk handkerchief was fastened to the shaft, which was then pushed on through the body, dragging the silk after it through the whole extent of this formidable wound.

He recovered from the effects of the wound and from this novel surgical procedure, and served actively for many years after.

In the report of surgical cases in the army since the war, I find the following somewhat similar case, reported by Dr. Goddard, U. S. A. His employee at Fort Rice, D. T., was wounded in February, 1868, by an arrow, which entered his back three inches to the right of the fifth lumbar vertebra and emerged at a point two inches to the right of the ensiform cartilage. During the following evening the patient lost, externally, about eight ounces of blood and a small (estimated) quantity, internally. He was confined to his bed some two weeks, suffering from irritative fever and circumscribed peritonitis. In four weeks he was walking about, and on July 1st was actively employed. There are no further particulars or comments on this case.

The route of the missile is a mystery. It would seem impossible that it could have been direct between the two wounds, as the intestines, stomach, and liver lie in the way. Both the great cavities would also have been opened. Penetrating arrow wounds of the abdomen are usually mortal.

Of nine cases reported in detail, seven were fatal; and of the two which recovered, it is doubtful whether the peritoneal sac was penetrated. One of the fatal cases was mine, and as it may be taken as a type of its class, I will give it here: A cavalry soldier was wounded while approaching an Indian camp at night, near the Canadian river, Texas, by an arrow which entered the abdomen in the left hypochondriac region, making a wound about three-fourths of an inch in length, through which about eighteen inches of the small intestine protruded. The gut was cut in four places. The wounds in the intestines were closed by sutures and the protruding portion returned through the wound, which was enlarged for the purpose. When found, the man had lain out all night, and was in a state of collapse. He was carried along with the column, in an ambulance, but died on the second day, never having rallied from the shock of the injury.

The great fatality of arrow wounds of the abdomen is so well known to the Indians that in action they usually aim at the umbilicus.*

Another case, which I personally observed, is so unique that I will briefly give its outline. It is an example of a penetrating arrow wound of the lower part of the trunk. The operation for its relief was done at Fort Sill, I. T., by Dr. Forwood, of the army, who reports the case. I assisted him and saw the patient up to the date of his removal.

"Latimore, a chief of the Kiowas, aged 42 years, applied at Fort Sill for treatment, with symptoms of stone in the bladder. In 1862 he had led a band of his tribe against the Pawnees, and was wounded in a fight. Being mounted and leaning over his horse, a Pawnee, on foot and within a few paces, drove an arrow deep into his right buttock. The shaft was withdrawn by his companions, but the point remained in his body. He passed bloody urine soon after the injury, but the wound soon healed, and in a few weeks he was able to ride without inconvenience. For more than six years he continued at the head of his band and traveled on horseback many hundreds of miles every summer. A long time after the injury he began to feel pain in urination, which increased until he was forced to reveal the sacred secret, as it is regarded by the Indians, and to seek medical aid. The urine was loaded with blood, mucus, and pus; the introduction of a sound indicated a large, hard calculus in the bladder. Judging from the cicatrix and all the circumstances, it was apparent that the arrow had passed through the gluteal muscles and the obturator (sciatic?) foramen into the bladder. On August 23 I removed the

stone by the lateral operation. The calculus was phosphatic, and weighed eight hundred and fifteen grains. On section of the stone, the arrow point was found embedded near its center. It was of iron and had originally been about two and a half inches long by seven eighths of an inch broad, in its widest part. The urine began to pass by the natural channel on the third day, and on the seventh day it had nearly ceased to flow from the wound. But the restless spirit of the patient's hand could no longer be restrained; open hostilities with the whites were expected to begin every moment, and they insisted on his removal. He needed purgatives on the eighth day, which they refused to allow him to take; on the following day they started with him to their camp, sixty miles away. Fourteen days after he is reported to have died. But his relatives have since assured me that the wound had healed, and that no trouble arose from it."

Notwithstanding a narrow pelvic outlet and the large size of the stone, there was every reason to expect a favorable result in this interesting case. These Indians possess remarkable powers of endurance and recuperation from wounds, due, doubtless, to their active life in the open air of the Western plains. But it is possible that the case may have been complicated by an induced disease of the kidneys.

They have in New Mexico a diet of Spanish origin, composed of meats of different kinds and vegetables of various sorts, and spices, mainly pepper; and this is served for a dinner, breakfast, or supper, as the case may be, and that is all there is. It is a good dish for a hungry man, but would not delight an epicure. It is called *olla podrida*, or, more simply, *olla*. One who does not like meat, would eat it for the sake of the vegetables and the flavor they have imparted; and one whose fancy turned away from the vegetables might take them on account of the meat in the essence of which they had been steeped; while he who would take neither flesh nor grass, might help himself to pepper.

Mr. President and gentlemen, it is an *olla* that I have set before you to-night.

THE THEORY OF THE "CONSERVATION OF TISSUE" BY THE USE OF ALCOHOL.

By Prof. E. CHENERY, M.D., Boston.

THE idea that alcohol arrests tissue change and thereby conserves the vital powers is so flattering that it has become very generally received, and is the chief argument of our day for the use of spirituous agents, especially where prostration of strength is coming on in the course of severe disease.

To my mind there is a grave error in this theory, which will appear in this paper.

Dr. William A. Hammond, of New York, I believe, was the author of this notion, and it was constructed out of and rests upon experiments like the following, which is one of his more recent, and was used in its support. Dr. H., during a period of five days, took 60 drachms, a little short of half a pound, of alcohol, with his usual amount of food, and gained 0.45 of a pound in weight. "In the same period," says he, "the amount of carbonic acid and aqueous vapor exhaled from the lungs had and gone diminution, as had likewise the quantity of urine and its solid constituents." Externally and for the time this shows a diminution of waste. Now that alcohol diminishes the elimination of carbonic acid and urea—the two forms of waste representing the combustion and the "wear and tear" of the system—is so clear that it may be assumed to be a matter of demonstration, and further questionings in regard to it may be dispensed with.

But does this decrease in the elimination of these wastes prove an arrest within, or "conservation" of those tissues which they represent in a living state? I think not; and if not in a living state, not in any useful state at all; and so the "conservation of tissue" is a myth, and does not take place; for who can think that dead matter can be healthful?

The theory assumes that the death and the discharge of the products of death are one and the same thing, and wholly overlooks the medium by which the elimination is effected. Now, nothing can be plainer than that tissue decay is one thing, and the removing of the products of decay is quite another. Any one can see that if there is no waste within none can be thrown off; while, on the other hand, it stands to reason that though there is an abundance of *débris* within, little or none can be cast out if the medium by which excretion is effected is rendered inoperative.

By winding a string tightly about my finger I do not necessarily destroy the life of the finger, nor will tissue change be arrested at once. I prevent the return of the blood from the part, which grows dark from the heaping up of the products of tissue waste which continue to take place but cannot escape. Indeed, a man with a rope about his neck does not die immediately, but his body becomes surcharged with waste carbon and turns black for want of air to take the carbon away; his heart continues to beat, and the tissue changes go on until the products kill him from within. Were it not so he would die scarcely sooner with the rope around his neck than with it under his arms, where the colored man wished it put in his case, as he said he "was ticklish in the region of the neck." A similar state of things is often witnessed by physicians in persons asphyxiated by drowning, croup, and various other suffocative diseases, in which the deprivation of air and its oxygen results in an accumulation of waste within, and consequently in failure of nutrition, nervous prostration, and, finally, in death, unless relief is afforded. In all these cases there is a diminution in the excretion of carbonic acid and urea, yet no candid man for a moment supposes that the tissues are in consequence conserved and the bodily condition made better by it.

But what more reason is there than to suppose the tissues are conserved in the presence of alcohol simply because there is a decrease in the excretion of the waste? The increase in the excretion of waste from the lungs and kidneys after the alcohol has passed off is against such a conclusion. The sum of the whole case then, is, that alcohol embarrasses the function of the blood globules, the active agents of the blood plying between the lungs and the tissues, and whose power of absorbing oxygen on the one hand and carbonic acid on the other experiment shows to be destroyed by the presence of alcohol; for as surely will alcohol annihilate the physiology of the blood globules as it will the physiology of yeast-cells, bodies having similar functions.

The fact is, tissue death is taking place all the time; and, as a rule, the processes of removal are equal to the demand, but in the presence of alcohol these processes are crippled and the full removal is prevented; since the alcoholized

blood globules cannot absorb the proper amount of oxygen from the air to oxidize the effete matter within, into which state it must be brought in order to its removal; nor can the alcoholized globules take up the products of this oxidation and remove them even could the oxidation be effected. It is, indeed, the office of pure air to charge the globules with oxygen, and, through them, to oxidize and remove the waste of the tissues, and there is no particle of evidence to show that the oxygen will attack and destroy the living tissues themselves; nor will the withholding of oxygen save the particles alive when their time to die has come, but only leave them to remain in their dead state to foul the system. By crippling, then, the gas-carrying function of the globules by the presence of alcohol, we prevent the due aeration of the blood and the elimination of effete matter, and the system, so far from having its tissues conserved, is thereby rendered filthy throughout. I would, therefore, ask, Is the man, long under the influence of alcohol and reeking from every pore with the stench of the heaped up unoxidized and unremoved dead matter, in such a state of conserved tissues as to offer a recommendation for the conservative power of alcohol? In such a state the man does not excrete the normal amount of either carbonic acid or urea. On the contrary, his tissues are conserved, that is, retained in his body as effete matter, and he will weigh that much more than he did.

Will not Dr. Hammond show us that this was not his condition after his painstaking experiment? Indeed did he not lose his new gained flesh immediately on the discontinuance of the alcohol and the recovery of the function of the globules to clear the system up again? If this is "conservation of tissue," it becomes the advocates of the theory to show the good of it. For what purpose do we want dead matter? Are there any circumstances under which it can be of advantage? Is not such a state of things always a state of disease, fever? Indeed if "cleanliness" on our exterior person "is next to godliness," what physiological virtue must there be in "cleanliness" within? Pure blood is life-giving, not destructive; it carries out the waste, but does not create it. If a checking of the function of the globules is a conservation of the tissues, on the same principle how admirably we might save a thickly-settled community from death by sending all the undertakers on a "bender," as we do the blood globules. Would not the community soon become pestilential from a neglect of the necessary burials? Proper burials and proper cleanliness will do more to save life and health than any such "conservation" as this. But to argue the health of a community from the few interments, when the undertakers are all drunk, is exactly the argument for the conservation of tissue from a diminution of the excretions when the body is under the influence of alcohol. Neither drunken men nor drunken blood globules can do their work.

It is in this light Marvaud sees things when he says ("L'Alcool, son Action Physiologique"), "One can explain how alcohol can check the nutrition and vitality of the blood globules, by causing a stay and a heaping up of materials in their interior which have become unfit for their functions, and, at the same time, checking the attractive and elective power which the globules exert over the useful and restorative matters contained in the serum."

I would like to ask the advocates of the "conservation" theory what they would think if another class of professed physicians should spring up and go among their patients tying cords about their necks to conserve their tissues and save their strength (to say nothing of such a practice on the well), and the worse the case the tighter to tie the cord? Would they not cry out against it and say, "Horrible! Unscientific! Irrational! Do not do that!"

Just so I feel in regard to the "conservation of tissue" by alcohol. It is an assumption not only without scientific support, but against science, and totally unwarrantable and unworthy the confidence of any medical mind. How the profession have jumped to so irrational a conclusion and totally ignored the functions of the blood globules in this connection so long, is a mystery to me. It will be time to argue for the "conservation of tissue" when we find that the crippling of the blood globules by alcohol does not answer all the facts in the case.

NEW EXPERIMENTS IN PREVENTIVE INOCULATION.

M. PASTEUR recently made a communication to the Paris Academy of Medicine which, according to the *Gazette Médicale de Paris*, "makes an epoch in the annals of science." Without admitting such a claim as this, the communication is certainly of interest in connection with previous remarks which we have made upon the subject of preventive inoculations.

When Pasteur discovered a method of so cultivating the specific germs of chicken-cholera as to give them the power of preventing the disease when inoculated, he asserted it to be possible to treat other specific organisms in the same way. This he has recently done for the virus of charbon. He was furnished with an unusually good opportunity of testing the power of his modified virus. The Agricultural Society of Melun put at his disposal sixty sheep, to be experimented with as he chose.

Ten of these were separated from the rest and kept subject to inspection. Twenty-five others were inoculated twice with the cultivated virus of charbon. After a sufficient time these and another twenty-five sheep were inoculated with the pure virus of the disease. The fifty sheep were then allowed to mingle together in the same inclosure. The twenty-five not "vaccinated" did not take the disease, while the others did. Those of the latter that died were buried in an inclosure together. A certain number of vaccinated and unvaccinated sheep were then turned into this inclosure and allowed to pasture there. The unprotected were soon attacked with the charbon, while the others were not. Thus M. Pasteur claims to have demonstrated not only the protective power of the modified virus, but also a previous assertion, that sheep pasturing upon ground where animals killed with charbon are buried, will catch the disease.

M. Pasteur made similar experiments with ten animals of the bovine species, and asserts that the same protective power was secured to them.

Pasteur's communication was received with applause by the society, yet it was not allowed to pass without criticism. M. Collu claimed, and with justness, that the same results had been obtained by himself a year ago, and by Toussaint a little later. He might have added that Greenfield and Burdon Sanderson had also experimented successfully in the same line. Still no one has ever obtained successful results upon so large a scale or with so much uniformity.

It was also suggested that it yet remains to be proved that the preventive power of the inoculations lasts for any considerable length of time.

* Dr. Bill, U. S. A.

Whatever be the question of priority, however, it is certain that Pasteur's results have attracted the most attention of any yet made in this line. And they will probably give a fresh impulse to studies in this direction. It must be remembered that the successes in preventive inoculation have, so far, been with diseases having a close pathological resemblance. And before the experiments of Pasteur, their practical application did not seem easy. — *Medical Record*.

THE PHENOMENA OF HYPNOTISM.

I.

CHARLATANISM and deceit have been so mixed up with all the facts regarding hypnotism, that it is now usual to say that whoever has had anything to do with the subject has either deceived or been deceived—he is either impostor or dupe; there seems to be no intermediate position. Even



Fig. 1.—Mode of inducing Hypnotic Sleep.

to day the best-informed minds refuse to believe in magnetism, as it is called, and find it less dangerous to turn away their eyes than to make a momentary examination.

It will be admitted that the experimenters at the Salpêtrière have exhibited a certain amount of courage in breaking with all traditions, in scorning all fear, and in meeting the subject squarely face to face.

We have, in order to prepare this article, read up everything rational that has been written on the subject; and what has struck us most forcibly has been to see to what extent an erroneous idea—a pure theory adopted at the inception of researches upon magnetism—has led authors to fall into ridiculous mistakes and cast over the doctrine a merited contempt.

The occurrence of curious facts attributed to magnetism could not fail to give rise to certain researches; but, by a great misfortune, the first observations got into the hands of veritable invalids. It would seem that certain persons have a love for the extraordinary, and that, in the face of an unexplained fact, they rather prefer to content themselves



Fig. 2.—Another Mode of inducing Hypnotic Sleep.

with supernatural explanations. Their minds, imbued from childhood with superstitious notions, have no repugnance to admit of like reasons.

The first adepts in magnetism found themselves face to face with new forces; psychical influence manifested itself under a form that had not before been observed; there was a new, imponderable fluid passing from one man to another, and permitting the first to impose his will on the second. Up to this point all was debatable, but interested charlatanism had not made its appearance. Soon, individuals who had been submitted to hypnotism began to talk medicine and to prescribe remedies. The first experimenters, otherwise full of honesty, were so simple as not to stop short, but went following charlatans and their inconsistencies, by whom they were made sport of. This was the second period of magnetism.

At that epoch there appeared hundreds of volumes wherein absurdity displayed itself in the strongest light. We ask ourselves whether these works of insane men were read, or whether the authors are not poking fun at us. Here we see physicians like Teste or Deleuze holding consultations in which are diagnosed diseases that never existed, even by name; and we find hysterical persons predicting their crises, which naturally occurred at the time appointed, and which were taken by observers for terrible maladies. The very wife of Teste predicted that she was going to die on such and such a day. What anxiety for the unfortunate observer!

The day arrived, all the adepts assembled, the hour passed by, and Madame Teste did not die. Do you think the author was confounded? By no means; if she did not die, it was because she had taken lethargy for death. Everything is arranged for.



Fig. 3.—Hypnotism produced by placing a lead pencil between the eyes.

We might compile entire volumes of analogous facts. But *oui bono*? We prefer to ask the reader to refer to the original authors, but we do not advise him to do so. It is truly pitiable to see how far the human mind can go astray.

Here are a few specimens, however. We copy from Vasseur Lombard the following method of curing cancer by magnetism:

"The magnetizer, after a preparatory magnetization, makes a few attractive passes at the seat of the disease with a will to draw off the impure fluids which feed it; afterward he makes repulsive passes toward the seat of the trouble with a will to intercept the bad fluid and drive it out; and he finishes by making passes without movements directed toward the seat of the disease, with a will to assuage the heat of the disease and to strengthen the weakened vital principle."

This same magnetizer is not at all proud, but treats animals also:

"The magnetization of sick animals is performed like



Fig. 4.—Hypnotism produced by suddenly extending the hand before the patient.

that of man. The magnetizer places himself before the animal, in the most convenient position possible, with reference to the shape or large or small size of the subject. He then begins by exercising his fluidic power upon the sick animal by repulsive passes made at a suitable distance, commencing at the head and following the back and sides as far as the extremity of the body, with a will to release the impure fluids which form its atmosphere.

"Afterward, the magnetizer makes a few mediating passes from the head, always following the back up to the extremity of the body, and continuing along the legs as far as the feet, with the intention of keeping up an equilibrium in the organism of the animal."

Magnetism is also applicable to horticulture:

"The magnetization of diseased plants differs, in its gen-

eral application from that of man or of animals, in the fact of its being performed from the base to the summit of the plant. The magnetizer stands up in front of the plant to be magnetized, and at a suitable distance from it. He exercises his fluidic action by repulsive passes made from the base to the summit, in following the trunk or stem and the branches, according to its importance, with a will to drive away the impure fluids that form its ambient atmosphere. He afterward relieves the interior of the plant by attractive passes made from base to summit.

"He continues the magnetic action by mediating passes, always making them from base to summit, and pausing a little at the junctures of the branches, with the intention of strengthening the vital principle of the plant, and causing the sap to circulate from its roots to its very uppermost branches. By the aid of these same processes one can magnetize the plants of a garden or orchard, an en-



Fig. 5.—Exploration of the cubital nerve excited by a pencil, and bringing on a contraction of three fingers.

tire crop of cereals, vegetables, or forage plants, either for the purpose of strengthening them or for making them grow; but for this magnetization the universal vital fluid must be employed. The plants of a garden, of the woods, of a field, or of a meadow may also be saturated with fluid so that they may serve as a hygienic promenade for invalids."

And there have been written thousands of volumes of just such character! It is certain that, in the face of trash like this, there was scarcely anything left for scientific men to do but to step aside and wait for a better period—for a moment at which, the simple being disabused and deceivers unmasked, they might be able to resume with advantage their studies on animal magnetism. If the measure did not possess great scientific liberalism, it at least had the advantage of being a good precaution and of stopping *en route* many minds that were about capsizing.

It was amid all these difficulties that hypnotism had birth. If the word is new, the thing itself is scarcely so. From antiquity we find a series of phenomena which are explain-



Fig. 6.—Excitation of the facial nerve by a pencil, producing the effects of a powerful electric current.

able only by this singular, induced neurosis; and without going back so far, we may be permitted to recall a few examples which are frequently met with in our own day, and even at the very moment at which we write.

In all ages, what has been termed contemplative asceticism has been produced by the prolonged fixation of gaze at some object, brilliant or otherwise, to which some virtue was attached and which was supposed to possess some sanctity.

These contemplations, aided by a violent intellectual excitation, were rapidly followed by hallucinations, apparitions, and even by a state of trance such as described both in thaumaturgy and medicine. The books of the Christian hagiographs abound in facts of this nature, and they are so well known by everybody that we shall not dwell upon them longer.

In India the devotees arrive at a like result by gazing into space; sometimes by looking at an imaginary point, and often, also, at the end of their nose. The effect never fails. We shall see further on that this is precisely the process that we are employing, we having merely submitted it to rule.

Among the Greek monks hypnotism is, perhaps, held more in honor yet than it is among the Roman. It is a fact known to all that these men succeed in falling into a trance by a prolonged contemplation of their navel.

Islamism itself, as little mystical as it is, has also given rise to special processes of hypnotization. A prolonged and monotonous sound has a more prominent part in them than has contemplation.

Among the disciples of Hussein the Martyr trance is brought on by means of tambourines continuously beaten with the same rapid and monotonous cadence. Some of the

of Manchester, after witnessing some experiments called magnetic, recognized the fact that the unquestionable phenomena that he had observed were to be attributed to prolonged fixedness of gaze, and not to any mysterious fluid.

It is with Braid that scientific magnetism begins. It would be departing from our subject to dwell longer on questions of history, so we shall refer the reader to the very remarkable article published on this subject by Mr. Mathias Duval in the *Dictionnaire de Médecine et de Chirurgie pratiques*.

Braid was satisfied to cause the subject to fix his eyes upon his own, but his successors still further eliminated the possibility of a fluid and human intervention by directing the person under experiment to simply fix the eyes on some object placed before and a little above him. This method succeeded very well, but it is a little slower than that of Braid.

nothing, not to allow his attention to be diverted toward examining the effects that he shall experience, to be hopeful, and not to be uneasy nor discouraged if the action of the magnetism produces momentary pains in him. After he has received you kindly, take his thumbs between your two fingers in such a way that the inner surface of your thumbs touches the inner surface of his, and fix your eyes upon him.

"You will remain in this situation from two to five minutes, or until you feel that there is an equal degree of heat between his thumbs and yours. This done, you will take away your hands, extending them toward the right and left, palms outward, and then lift them up as far as the head. Then you will place them on his two shoulders, and allow them to remain there about a minute, and afterwards draw them down along his arms to the ends of his fingers, touching the latter lightly. This pass is to be repeated five or six times.



Fig. 7.—Cataplexy induced by opening the eyelids of the sleeping patient.

initiated ones accompany with a chant, which is rhythmized on the sound of the tambourine. The ceremony often takes place at night, and the adepts soon fall into a sort of trance, in which the insensibility of their skin is such that it is possible to reproduce upon them the different phases of the martyrdom of the master, without eliciting from them a cry and without their even seeming to know anything about it.

It is, however, with the sect of Aissaoua, many representatives of which are met with in our Algerian colony, that the phenomena are exhibited with the greatest intensity. Those who have had the chance, which is very rare, of being present at one of their ceremonies have been struck with the degree of anaesthesia with which these men are affected.

The thing usually occurs at night in some isolated plain; the noise of the tambourines is heard, and the adepts are seen seated around a large fire. Gradually they fall into a trance, and some are even seized with convulsive symptoms and utter prolonged cries. Anaesthesia becomes complete,



Fig. 9.—Same phenomenon produced by the explosion of gun cotton.

This, then, is the only important operative manual; all else smacks of charlatanism or of ingenuousness.

II.

Among the number of the ridiculous "magnetizers," there have been some who, while persisting in their errors, have nevertheless employed methods that were somewhat scientific. The name of Teste, for example, has often occurred to us. Him we have always considered as one of those men who are deceived in good faith; and we shall therefore borrow a few passages from his book on the manual operation of magnetism.

From this the reader will be only the better enabled to see what the state of the question was when the Salpêtrière experimenters began to make it the subject of their studies. Here are a few extracts:

USUAL METHOD, AFTER DELEUZE.

"As soon as you have made up your mind and have de-



Fig. 8.—Cataplexy induced by the sound of a tom-tom.

and then some of them are seen to put their tongue to a bar of red-hot iron, while others, saturated with blood, chew up prickly pears, whose long spines pierce their cheeks through and through. Certain of them swallow living spiders and scorpions—a proceeding which may be followed by grave accidents.

In reality all of these unconscious hypnotizers proceed always in the same manner: fixation of the sight (in general with convergent strabismus), or fixation of the hearing on some noise which is always the same.

These are the processes which our predecessors have always employed, and which we do also, for reproducing phenomena that are, as will be seen, entirely determinate. It is to Braid that we owe the first well-defined operative manual of hypnotism, and it was in 1841 that this surgeon



Fig. 10.—Cataplectic patient following the fingers of the physician.

cided to treat the thing gravely, remove from the patient's presence everybody who might possibly incommode you, and keep by you only the witnesses necessary (one, if possible), and ask them not to busy themselves in any way with the methods that you employ nor with the effects which follow them, but to join with you in the intention of doing the patient good. Manage so that you shall be neither too warm nor too cold, in order that there may be nothing to prevent your motions being free, and also take precautions that you be not interrupted during the *séance*. Then cause your patient to seat himself as comfortably as possible, and place yourself opposite him upon a seat a little higher than his, and in such a way that his knees shall be between yours and that your feet shall be alongside of his.

"Ask him, in the first place, to give himself up, to think of



Fig. 11.—Cataplectic patient suddenly falling.

You will afterwards place your hands above his head, hold them there a moment, and then bring them down before his face, at a distance of one or two inches, and stop at the pit of his stomach, against which you will rest your thumbs for about two minutes. Then you will pass slowly down along his body as far as his knees, or, what is better, if you can do it without disturbing yourself, as far as the ends of his feet. You will also occasionally get near enough to the patient to lay your hands on his shoulder in order to pass them slowly down his spine, and from thence on his hips and along his thighs as far as his knees or down to his feet. After the first passes you may dispense with laying your hands on his head, and may make the subsequent passes upon his arms, beginning at his shoulders, and upon his body, beginning at his stomach."

The method of which I have just read the description is, in general, that which must be followed when one wishes to begin in magnetizing. However, I think I may observe that absolute contact of the hands with the head and epigastrium is not indispensable, but, on the contrary, is a subject of



Fig. 12.—A cataplectic patient who thinks she is pursuing a bird.

distraction and adds nothing to the efficacy of the treatment. I believe that I have found, too, that the passes practiced along the rachis have no well-marked action; and, for my part, I have for a long time stopped making use of them.

Finally, as a general rule, all species of direct touch appears to me to be superfluous; and, for the very interest of their practice as well as for the sake of propriety, I ask all magnetizers to abstain from it. Most usually I stand erect before the person whom I desire to magnetize, and even at a certain distance from him.

After the few minutes' meditation which should precede every experiment, I raise my right hand to the height of his forehead, and direct my passes slowly downward, in front of his face, breast, and stomach; only, every time I raise my

hand, I take care to let my fingers drop in such a way that their dorsal surface is directed toward the magnetized person during their ascent, and their palmar surface during the passes. This process is simple—too simple, perhaps; and so I would advise that it be employed on subjects who are already accustomed to magnetism and susceptible of being easily put to sleep. Deleuze's method, with the slight modification that I have indicated, is much preferable for preliminary trials.

But, strictly speaking, all processes succeed when those who employ them are inspired with confidence in them, and when they have full reliance in their power.

MAGNETIZATION BY THE HEAD.

"This is one of the promptest and most energetic processes that I know. It is as follows: Seat yourself in front of the person whom you wish to magnetize; first make some long passes downward in the direction of his arm, before his face and on a line with the axis of the body, after which extend your two hands at some inches from his forehead and parietal regions, and remain thus for a few minutes. For the whole time that the operation lasts vary the position of your hands but little, being satisfied to move them slowly from right to left, then to the occiput, and afterward to the forehead, where you will leave them indefinitely—that is to say, till the subject is asleep. Then make passes over his knees and legs in order to attract the fluid downward (to use an expression of magnetizers).

"The fact is, the intervention of the fluid is at least very convenient in order to explain clearly what one desires to make understood; and, in the case of which I speak, I should like to be sure that this imponderable exists, in order to be able to say that, in recommending these passes over the lower extremities, I am advising a revulsion, or rather a magnetic derivation."

MAGNETIZATION BY A FIXED GAZE.

"This process cannot be employed by everybody. It requires in him who makes use of it a quick, penetrating look, susceptible of long fixedness; and it would succeed only very rarely with subjects that were being magnetized for the first time, although it happened with me recently that I was able to put to sleep, at the first *séance*, a man thirty years of age, who was undeniably more robust than I. Moreover, I scarcely ever magnetize my practiced somnambulists in any other manner, when it becomes a question of some experiment with vision; for I believe that I have discovered that this kind of magnetizing increases clear-sightedness. The following is the mode of operating:

"Seat yourself opposite your subject, and get him to look at you as fixedly as possible; while, on your part, you fix your eyes on him continuously. A few deep sighs will at first heave his breast; then his eyelids will wink, moisten with tears, contract strongly several times, and then finally close. As in the process previously described, so here also there is occasion to terminate by a few passes over the lower extremities; but still, if your patient has offered you some resistance, you will have trouble in preventing him from having those attacks of headaches which magnetizing by the eyes easily occasions, and which you yourself will not always be exempt from. Experience, moreover, has proved to me that the nearer the magnetizer is placed to the magnetized, the more powerful is the action of the gaze, but still there is nothing to prevent magnetizing being accomplished at considerable distances."

FAVIA'S METHOD.

"The Abbé Favin, a celebrated magnetizer, who exhibited his somnambulists in public, and who died with the finest reputation as a charlatan that any man in the world ever had or ever deserved, in order to increase what there was of marvelous in his experiments, and therefore to give more *éclat* to his exhibitions, invented a method which had no imitator and which hardly succeeded except in his own hands. He caused the person who wished to submit himself to his operations to be seated comfortably in an arm chair, requested him to close his eyes, and, after a few moments of reverie, said to him, in a loud and commanding voice, 'Go to sleep!'

"These simple words, uttered amid a solemn silence, by a man of whom wonders were told, usually made an impression upon the patient sufficiently deep to produce a slight tremor of his whole body along with perspiration and sometimes somnambulism. If the first attempt did not succeed, he submitted the subject to a second, and then to a third, and even a fourth trial, after which he declared him incapable of falling into an intelligent sleep! This method does not differ essentially from the preceding, except that the cabalistic apparatus with which the Abbé intimidated the weak and credulous minds which yielded themselves up to him, by neutralizing in the latter every sort of moral resistance, prepared them for more promptly receiving the influences of a will which was in some respects powerful."

From reading the foregoing and taking into account the errors committed by the authors in very virtue of their preconceived ideas, one will easily deduce therefrom the manner in which we must proceed to produce hypnotism, and the moment has now come to make known to the reader the processes used at the Salpêtrière.

In order to produce phenomena of hypnotism we must first select our subject. There are few women who cannot be hypnotized, and there are even certain men in whom the thing can be very easily effected. But we shall attain the object more quickly and surely by taking a hysterical female. Of these young ones will be preferable, as they are more sensitive and impressionable. Some are great readers of romances and possess characters which are hardly ever lacking in sentimentality; these are to be preferred to those who are coarse.

The latter may be caused to fall into the hypnotic sleep, but not so quickly, and the manifestations are heavy, while some hysterical-epileptic crisis usually ends the experiment.

The choice being made, the patient is seated before the operator (Fig. 1), who looks her in the eyes. Here, say the magnetizers, it is necessary to have a *will* to cause sleep. This is absolutely useless, for the operator may think of anything he chooses, provided he keeps his gaze fixed and winks as little as possible. The thumbs of the subject are held in his closed fingers only in order to fix them firmly, and not in anywise for the passage of any fluid. Passes are absolutely useless, and would serve only to retard the inception of sleep.

After two or three minutes of this state of immobility, the eyes of the subject are observed to reddens and to become injected slightly, and tears begin to moisten her eyelids and roll down over her cheeks. It is necessary to persist in looking at her steadily.

The subject often closes her eyes of her own accord and

falls backward; but if such an effect does not occur spontaneously, the operator lets go her hands, and places his thumbs on her eyeballs, closing the eyelids slightly as he does so (Fig. 2). Sleep then ensues at once, the patient in falling back heaving a succession of sighs, and a little foam sometimes making its appearance on her lips.

The simple application of the thumbs to the eyeballs may sometimes induce hypnotism without a preliminary fixation of gaze. The method is specially fitted for use with patients who are somewhat restive and whose attention cannot be fixed for a sufficient length of time.

Again: both methods may be at times advantageously combined. The eyes of the subject may be fixed by pressing the thumbs against her eyelids, while the fingers clasp her temples. There results from this an uneasy feeling which greatly hastens the approach of sleep. In some cases, when, for example, the operator desires to avoid being com-



Fig. 13.—A cataleptic patient who thinks she sees a snake.

pared with a magnetizer, or when, in order to convince an auditor, he desires to prevent any possibility of the phenomenon being interpreted as due to a fluid, he may proceed as do the successors of Braid.

The patient is seated on a chair, and between her eyes there is placed any kind of an object whatever (a pencil or penholder is excellent for the purpose), and she is told to look at it steadily (Fig. 3). Under such circumstances sleep again supervenes, and with the same preliminary symptoms as we have described above. As may be seen, there is nothing more simple than the production of hypnotism; there is nothing mysterious in the processes, and there is nothing, moreover, more than ordinary in the results.

What we have said thus far applies to the first essays that are made upon any given subject, but after a patient has already been often hypnotized the thing may be accomplished much more speedily and easily.

Here it is that imagination comes in and that charlatans find their opportunity. The sole idea that she is going to be put to sleep causes the patient to go to sleep quite sud-



Fig. 14.—A cataleptic patient fixed to a wall.

denly. If with this she be made to believe that magnetism possesses a secret influence, a supernatural power, see where this will lead to. A patient at the Salpêtrière, G—, persuaded that one of us had a peculiar power over her, fell down hypnotized in whatever place she met him; and we have seen her go to sleep in the middle of a pathway and on the stairs, etc. One day, when in joking with her, she had been made to believe that she would be suddenly put to sleep by *will* in the midst of a public ceremony that was to take place a few hours later, she preferred to stay away from the latter, so firmly was she persuaded that the thing was inevitable.

In such cases as this imagination is everything, and everything takes place in the subject. A few examples will make

this well understood. If we have a patient who is well trained and who becomes quickly hypnotized, it will be sufficient to suddenly extend our hand over her head (Fig. 4), when she will drop as if struck by lightning. We cite this experiment because it is easy to perform and is often employed by thaumaturgists; but no matter who does it, the result is the same.

It has often happened that we have persuaded patients that they could not leave the room in which they happened to be because we had magnetized the door knobs. They hesitated a long time before touching the latter, but after they had done so, they dropped down asleep. Is it necessary for us to say that we positively had magnetized nothing at all? This experiment is important in that it explains to us those cases in which subjects fall asleep on drinking a glass of *magnetized water*, and in which others are overcome on lying down under a magnetized tree.

Experiments on magnetization at a distance belong to the same category and are dependent upon the same cause. How many times do we read in the books of magnetizers that these have succeeded in putting a patient asleep from their own apartment through a door or through space? Here again all is in the subject. We have often performed the experiment.

Some one said to the patient P—: "Mr. X. is in the next room and is magnetizing you." She then exhibited some inquietude and went immediately to sleep. We then showed ourselves, and the effect would have been very great had we desired. The same thing was said to her another day, and sleep supervened fully as quickly, although this time we were not in the adjoining room, nor even in France, and were not thinking of her.

On another occasion we said to a patient that, from our own house, we would put her to sleep at three o'clock in the afternoon. Ten minutes afterwards we had forgotten the jest. The next day we learned that, at three o'clock, the patient had gone to sleep. The immense majority of the absurdities which fill the books of magnetizers can be explained in this way—the imagination of the patient being very vividly impressed, and sleep coming on subjectively without the intervention of any external maneuver.

All the maneuvers that we have just described induce hypnotic sleep, and it is probable that a great number of others would have the same result. In order to eliminate absolutely the presence of man, and to remove all idea of an intervention of a fluid, we have often employed simple physical agents.

It is well known since the appearance of Mr. P. Kircher's work, that animals—cocks in particular—can be easily thrown into the cataleptic state by the simple fixation of their gaze upon a brilliant point. It is even asserted that the brilliant eyes of feline animals serve them for fascinating and putting their prey to sleep. Preyer has written on the subject of this fascination in animals a work which may be consulted with advantage. The same thing is easy to repeat on man, and by placing our patients before a fixed luminous point we have often succeeded in putting them asleep.

Further on, it will be seen that this constitutes even the best method of producing catalepsy. However this may be, here are a few experiments which it is possible to reproduce during the state of sleep. It suffices to excite the muscles slightly with the hand to cause them to immediately contract.

We shall dwell upon a single point only of this subject, that is, muscular hyperæsthesia, which is developed to such an extent during hypnotic sleep that it is possible to make, by simple contact, an exploration as delicate as could be performed by means of localized electrization.

Figures 5 and 6 show, one of them, the exploration of the cubital nerve excited with a pen-holder, and bringing about a contraction of all the fingers of the hand, except the second and third—a result which is also given by electrization, and which explains the very distribution of the nerve; the other figure shows the excitation of the facial nerve under the same conditions of hypnotism—an excitation which produces all the effects that a powerful electrical excitant can alone effect in the normal state.

III.

PRODUCTION OF CATALEPSY.

In hysterical persons *catalepsy* may be produced in several ways. The simplest consists in causing the subject to pass directly from hypnotic sleep into the cataleptic state. On going to sleep, the subject closes the eyes, and during the whole duration of sleep the eyelids continue to throb with great regularity. In order to induce the cataleptic state, it is merely sufficient to partially open the eyelids, as shown in Fig. 7, and the patient then immediately begins to exhibit all the phenomena which are characteristic of that state. Looking at a brilliant object always produces the same results. We have often seen some of our patients fall into the cataleptic condition without any apparent cause. One of them stated to us that she often dropped asleep while sewing, and that on these occasions she slept while sitting upright, thus bringing upon herself frequent scoldings from her family and her patrons.

Fakirs fall into the hypnotic state by looking steadily at some brilliant object, such as the moon or a star. We have readily produced the same effect by placing subjects before a very brilliant oxyhydrogen light, when they at once went into a trance. The sudden extinction of the luminous point causes them, on the contrary, to pass at once into hypnotic sleep again. The thing may be repeated indefinitely. It suffices to reopen the patient's eyes in order to have a return of the catalepsy, and to close them again to cause it to disappear anew. It has been found even that it is enough to open a single eye to have a *hemi-catalepsy* and a *hemi-hypnotism*.

Among Oriental peoples a monotonous and oft-repeated sound brings on catalepsy. This is very easily verified. The sound of a large tuning-fork instantaneously cataleptizes a female patient who is seated; and stopping the sound at once puts an end to the catalepsy, and brings on hypnotic sleep. It must not be supposed, however, that it is necessary to prolong the sound or the light. The sudden and unexpected noise of a tom-tom (Fig. 8) or the explosion of a package of gun-cotton, lighted by an electric spark (Fig. 9) brings on catalepsy instantaneously.

During the cataleptic condition it is possible to produce a few phenomena which certain magnetizers have styled *fascination*. The operator fixes his gaze steadily upon the patient, or causes the latter to look at the end of his fingers, and then he slowly steps backward (Fig. 10). From this time the subject follows him everywhere without taking her eyes off him; if the operator stoops, the subject does so likewise, and if the former turns around suddenly, the latter quickly follows him in order to catch his glance again. If the operator starts quickly forward, the subject falls behind

and walks exactly in a line with him. This experiment must be conducted with great care, since the patient does nothing to prevent herself from striking against objects, and would fall directly on her head if an assistant did not support her (Fig. 11).

In this state of *fascination*, the hypnotized subject belongs absolutely to the *fascinator*, and violently repulses everybody who interferes, unless, at least, such person's purpose be to go through with the maneuvers necessary to catch the gaze of the subject by means of his eyes, in order to recommence the experiments on fascination on his own account.

To finish up this subject, we must say a few words on two maneuvers, one of which permits of obtaining induced hallucinations, and the other, although often employed by magnetizers, has no connection with hypnotism.

In order to induce hallucinations, a subject who is young and has been hypnotized for some time past must be selected. She is thrown into the cataleptic state, and then when the operator has by means of his gaze succeeded in *fascinating* her (we are obliged to employ terms already in use), he simulates certain acts—making believe, for instance, that he is chasing a bird (Fig. 12). The hypnotized person is immediately seized with a like hallucination, begins to pursue the imaginary bird, and performs a series of automatic movements relating to the act which has been suggested to her. These hallucinations may be varied *ad infinitum*; the operator may, for example, assume a look as if he were frightened at a snake, and then the subject becomes seized with terror also (Fig. 13). It will be readily seen that there is scarcely a limit to such experiments, and so we need not dwell further on the subject.

The second point to which we have to call attention is the reflex contraction which may be produced in hypnotized subjects. If, for instance, a hypnotized patient be placed in the position shown in Fig. 14—that is to say, her hand resting against a wall, her body bent forward and its whole weight supported by her arm, it is found that she remains as if soldered to the wall and is unable to leave it. All this is very simple, and quickly explained. Let any one place himself in the situation represented, and he will find that it will be impossible to get out of it without bending his arm and then pushing himself away from the wall in order to regain his equilibrium. Why does not the hypnotized person do this? Simply because in an instant her arm is contracted and incapable of moving. This may be proved by removing the patient, when her arm will be found so rigid that it will require considerable pressure to make it drop. This case of reflex contraction is not so much due to hypnotism, because it is easy to produce it in the waking state. It is only necessary to pull strongly on the arm of almost any hysterical person to put it in a state of rigidity.

In conclusion, we ought to say a few words in regard to hypnotism among animals; but no success has been obtained in the experiments at the Salpêtrière, and we must refer the reader to the memoir recently published by Preger, which, although in our opinion erroneous as to the interpretation of phenomena, contains notwithstanding one of the completest descriptions.—*Drs. Bourneville and Regnard, in La Nature.*

EXCESS OF SILVER NITRATE IN GELATINE EMULSION.

It will, we feel, be of advantage to our readers to draw their attention to the subject of gelatine emulsions containing silver nitrate in excess, although by many it may be thought to be out of date, if indeed it has not entirely dropped out of mind. It is not, however, so very long ago that Prof. Vogel pointed out that his collodio-gelatine emulsion would bear the addition of a notable quantity of silver nitrate without the production of red fog; and not only so, but, by this addition, the sensitiveness of his emulsion was increased at least one and a half times. He found also that this increase of sensitiveness was soon lost again; so much so, that, at the end of twenty-four hours, the emulsion had gone back to its original state of sensitiveness.

But in the case of ordinary gelatine plates, the presence of free silver nitrate has a marked effect in reducing the length of exposure, provided only that the salt be not allowed to act for too long a time on the sensitive film. Stosch adopted the following plan: He mixed one or two parts of a solution of silver nitrate in water (1:15), with ten parts of ammonia, and one hundred parts of water; in this mixture the dry gelatine plates, when finished, were bathed for from three to four minutes, and after being taken out, were found to dry in five minutes at most. A plate prepared in this way is, after desiccation, from four to five times as sensitive as one which has not been submitted to the bath, and at the end of an hour shows very little sign of alteration, though if kept for a longer time it will begin to decompose.

We have successfully repeated these experiments with pure bromide, as well as with iodo-bromide gelatine plates, and have found that a very dilute solution of silver nitrate, without any ammonia, considerably heightens the sensitiveness. This successful result may be obtained, both with the alkaline pyrogallic and the ferrous oxalate developer. If the silver solution be too strong, red fog will appear in developing, and the same occurs when the silver solution dries unequally; great care must, therefore, be taken to secure cleanliness.

The question now arises, How is it that this effective action of silver nitrate has only recently been observed? Why have our experiments until now always given bad results when silver nitrate was added to the emulsion? In all the text books it is stated that, if there be an excess of silver nitrate in the emulsion, red fog will be produced. And this statement is perfectly correct; for if, in the preparation of silver bromide emulsion, superabundant silver be present, and the emulsion be then heated and flowed over the plates, these, when dried, will be found to be bad. The reason is, that gelatine in water when heated, decomposes the silver nitrate, so that the sensitizing substance becomes inactive, and, what is more, the decomposed salt itself has an injurious effect.

For this reason Gaudin, who, in 1861, prepared an iodo-bromide emulsion with an excess of silver nitrate, failed in getting a good result; Maddox, who, in 1871, was the first to produce gelatino-bromide of silver in the modern form, also made the mistake of adding too much nitrate. These attempts had the effect at a later date of giving currency to the dogma that gelatino-bromide must be prepared with an excess of bromide.

But at the present day we have come to the conclusion that substances which, in large quantities, have an injurious effect on gelatino-bromide of silver, may, under certain circumstances, be of great advantage. This, as we know, is true for hyposulphite in the oxalate developer, and now, as we see, for silver nitrate in the gelatino-bromide emulsion.—*Photo. News.*

EFFECT OF COLD ON GIANT POWDER.

GIANT powder freezes at about 44° Fahr., and gradually becomes hard, when it cannot be exploded with the giant powder caps. When received at a mine and is not already frozen, it should be kept in some warm place, where it cannot freeze, to avoid the trouble of thawing it. When the powder is frozen it never should be used for blasting. The powder may be in a granulated state, apparently soft to the touch, and yet the nitro-glycerine (the explosive property of the powder) be so chilled that its strength is only partially developed by an explosion. Frozen powder, when confined in a drill hole, can be exploded by using a heavy primer of thoroughly thawed giant powder No. 1. Knowing this fact, it is foolhardy for men to try to pick out a charge of frozen powder from a drill hole, as it is always more or less attended with danger.

The Giant Powder Co. issue the following instructions as to the best methods of thawing the powder when frozen:

1. Put a layer of cartridges of frozen powder in a box partially filled with hot ashes, or sand, of about 100° Fahr., and cover them well with the same material. Many miners prefer this to any other method for thawing powder.

2. Put a layer of cartridges in a wooden box and place the box near the boiler in the hoisting works or mill, or other warm place, turning the cartridges, from time to time, until the powder becomes soft and warm. It is then ready for use. The warmer the powder is when used, the greater the execution of the blast. After being well thawed it should be used at once before getting cold again.

3. Miners, by placing several cartridges in their boot legs, when going to work, will find the natural warmth of their bodies sufficient to thaw the powder, while they are "striking in a hole."

4. During the winter months, keep the powder in a warm, dry room, on shelves or slats; when once thawed out, it will remain so.

The latest improvement in this direction is simply a jacketed chamber containing shelves on which the cartridges are laid, a small furnace underneath heating the water in the jacket. By this means the cartridges can never be heated above the boiling point of water, and there is no danger of explosion. The Giant Powder Company are now making these little furnaces for use at mines and on railroads. One large railroad in Oregon is now using some 50 of these thawing furnaces. They are easily carried along, and a fire can be built in them right where they stand, wherever that may happen to be. At mines the furnace could be placed in any convenient position.

GELATINE EMULSION WITH THE ADDITION OF RESIN.

In some previous articles in the *Correspondenz* describing my experiments with gelatine-collodio emulsion, I mentioned that an emulsion which would set and dry rapidly could be obtained by dissolving the gelatine in as little water as possible, and diluting with a sufficient quantity of alcohol. This method of preparation imparts to the gelatine emulsion properties which have induced me only to prepare it so. Bromide of potassium and nitrate of silver are dissolved in boiling alcohol and added to the fluid gelatine. It may be ripened for a long time at a high temperature; indeed the temperature may even for a time exceed boiling point, without the gelatine becoming decomposed or the emulsion furnishing a film with a tendency to fog.

I wash it for from sixty to seventy-two hours in running water. In that way there is a perfect interchange between the alcohol and the water. When that does not take place the emulsion flows with difficulty over the plates. In spite of this long washing the emulsion retains the properties of setting rapidly and of furnishing a dry film in a few hours. The emulsion also keeps undecomposed without the addition of any antiseptic ingredient whatever, even during the hottest season of the year, and even should it be repeatedly made fluid. Thus one of the greatest drawbacks of the process is prevented, and that prevention will certainly lead to the further adoption of the process.

The addition of resin, as far as my experience goes, keeps quite well in collodio emulsions, so I tried the experiment with gelatine emulsion in order to see what result would be obtained. I added a solution of bleached shellac in alcohol to a gelatine emulsion after it had been ripened, but before it had been allowed to set preparatory to washing. The film poured with this emulsion set and dried more rapidly than without that addition, and I had a very beautiful matt appearance. The sensitiveness to light remained unchanged. Negatives taken upon it were vigorous and thoroughly good, and, unvarnished, had the appearance of having been taken upon fine ground glass. Prints from them had a very harmonious effect. The film dried very firmly, and, without any coating of varnish, took on pencil touch easily. One kind of gelatine which always gave an emulsion with a strong tendency to frill was tried with the addition of resin, and then gave a film which adhered firmly. These plates are much liked by my clients for portraits.

One of our oldest writers, Herr A. Martin, of Vienna, if I do not mistake, said long ago in one of his works: "It is easy to say what is to be done and what should be left undone in practical photography, yet success is often very problematic." This is quite true of the preparation of gelatine emulsions. With all care the emulsions often turn out quite different from what one has been led to expect. Now, in order to obtain an emulsion which shall always furnish me with plates having the same properties, I prepare three or four batches simultaneously in which the proportions of the silver to the bromide of potassium are different, and to ripen which different degrees of temperature are employed. Each batch is tested separately, and from the results obtained I decide in what proportions to mix them.

This plan would take up too much time for very busy photographers to try it, and for those that have not much to do it would be too expensive; but it might be adopted by those who, like myself, prepare plates and emulsions for sale, in order that their customers might depend upon always getting the same article. In this way also it is easy to comply with the special requirements of individuals. One wishes very powerful negatives; another likes them soft, thin, or delicate. The demands made upon the character of the negative are very various, so, therefore, are the properties of the gelatine emulsion.

What properties should a good gelatine emulsion possess? First of all, I consider it important that it should be in a condition to permit of the development taking place by a yellow light (because red light has a very injurious effect on the eyes) clear enough to permit of that development being controlled without training the eyes and without producing fog. The normal sensitiveness should be such as to allow a good portrait to be taken in a glass house in four or five

seconds. This exposure should be capable of being considerably shortened by the employment of suitable developers, such as the use of hyposulphite of soda in the ferrous oxalate developer. On the other hand, the emulsion should be capable of bearing a considerable degree of overexposure without danger of fogging. Plates possessing the properties place the photographer in a position to develop the negative with the character most to his taste, and to work with reliance on the result. For the practical photographer this last is generally the most necessary condition of all.

There is also the possibility of making instantaneous views upon gelatine dry plates; but the preparation of such will remain pre-eminently the specialty of those who find sufficient recompense in one success for many failures. All the instantaneous plates which I have made myself or seen done by others suffer from a sickly technique, particularly in the shadows; therefore he who wishes to make instantaneous views should not be a stickler for the perfect fulfillment of all technical demands. Extremely thin plates give thin negatives, which require intensification; but the difficulties which this latter defect presents in the case of gelatine plates are quite overcome. I now use always, without exception, the following intensifying solution, which renders me good service, and which I can therefore recommend highly. The intensifier is prepared as follows:

Corrosive sublimate twelve grammes, dissolved in 600 c. c. of water. After complete solution add a solution of eighteen grammes of bromide of potassium and eighteen grammes of iodide of potassium in 400 c. c. of water. Then add, of a solution of hyposulphite of soda (which has been used for fixing paper prints, and thus contains a little silver), as much as shall cause the mixture, when shaken up, to lose the red color which it had assumed, and to retain only a Naples yellow turbidity. After standing for sixteen to twenty-four hours the mixture is filtered from the slight, pale yellow deposit, and then from eight to ten grammes of the following gelatine solution is added:

Dissolve three grammes of gelatine in sixty c. c. of water and thirty six grammes of acetic acid. When this gelatine solution is added a white precipitate appears, which, on being agitated, becomes finely divided and imparts a milky turbidity to the mixture. In a few days the mixture becomes clear, but even in its turbid state it may be used. If the negative be intensified soon after being fixed the operation may be performed in the hand. The intensifying solution is poured upon the negative while well covered with water. It has rather an energetic action, which can be interrupted and the negative well rinsed when sufficient power has been obtained.

In the case of negatives which have to be intensified after they have been allowed to dry, it is best to moisten the plate well with water, and then to lay it in a shallow dish containing the intensifier three or four times diluted. Subsequent treatment with hyposulphite of soda is generally unnecessary. It is only in exceptional cases, when the intensification has been very much forced, and the negative has assumed a deep yellow color, that it is necessary to flood the plate once or twice with a weak solution of hyposulphite of soda. This causes the yellow color to disappear, and the strength of the negative is somewhat increased.—*Fr. Wilde.*

RETOUCHING GELATINE NEGATIVES.

By WILLIAM SHAWCROSS.

THE first thing I do on receiving my batch of unvarnished negatives for the day is to write the name of the sitter on the negative with a stocking needle. This I find is a better plan than writing with ink. The ink occasionally gets washed or rubbed away, but the name scratched in with a needle is always there.

I next carefully rub every part of the negative to be worked upon by the following medium:

Turpentine 4 drachms.
Gum-dammar 6 grains.

I do not recommend making up a larger quantity, as it seems to work better when fresh.

With regard to this retouching medium, I cannot say too much in its praise. It takes the lead more freely than any other medium retouching varnish, or any of the modes of rubbing the varnish to get a "bite" for the lead. I can use a much coarser point on the pencil, which is a great advantage, as the work is finished much quicker than with a fine point. It is astonishing what can be done with an under-exposed or a thin negative by means of the medium; and finally, the work does not run in the least when varnishing, and has a much softer effect.

In case the negative should require a little more work after varnishing, or some slight alteration, I lightly rub the varnish with a little powdered resin on the tip of my finger. I prefer resin, as it does not leave any mark or halo round the head. This, however, I only do in exceptional cases, as the advantages of having no retouching on the varnish to rub away are obvious, more especially when the prints from the negative are for publication. Should the negatives get dirty from long printing, the varnish can be washed off with methylated spirits, and varnished again without injury to the retouching.

The medium I keep in a small glass stoppered bottle, and I apply it by getting a little on the top of my finger, and rubbing it gently on the negative until it is almost dry, softening away the edge, so that there is no line round the head.

After my negatives are all rubbed, I take each one in the order of sitting, or as the emergency of the case requires, and carefully take out all spots and freckles with a Faber's B or HB pencil. With a harder pencil (from H to HHHH, as the density of the negatives demands) I next soften the lines and curves of the face. With a circular motion I then go all over the face, taking out what catches my eye first, not commencing at the forehead and working down, but doing a little on the forehead, a little on the lighted side of the face, and then a little on the shadowed side—in fact, running from one part of the negative to another, until the face is entirely finished. This I find is much better (so far as keeping the likeness and character of the face is concerned) than the plan of beginning at the top, and finishing every part of the face as you work down.

When the face is finished or "modeled" to my satisfaction, I again take a soft lead and lighten up the hair, strengthen the lights on the frills, collars, and dress if required. I then finish off the negative by spotting out with a sable-brush and Indian ink. I take out every spot, so that it does not show either black or white in the print. It is worth all the extra trouble to do this, for while on the negative you only have to do it once, on the print it is six, twelve, or twenty-four times, and in case of publication an unlimited number.

I use an ordinary retouching desk, and work with an open aperture, regulating the light by means of sheets of paper laid on the bottom, and ranging from white to a dark blue; the one I generally use is of a medium blue, which I find does not try the eyes so much as white, while at the same time it gives more body to the negative. On dark days, or for very strong negatives, I use a piece of silvered glass to reflect the light.

When my day's work at retouching is done, I proceed to varnish my negatives with the following varnish: I put orange shellac into a wide-mouthed bottle until it is two-thirds full, fill up with methylated spirits, cork, and let it stand for a day or two, shake it well, and filter. If too thick, dilute with more spirit to the strength required. This varnish is the best, and at the same time the simplest, I have yet tried. It is very hard, does not get tacky even in the sun, resists damp, and does not gather dust. I have used it for some years for wet plates, and never found a negative that had had this varnish to crack or leave the glass, and it does equally well for gelatine plates.

In winter I varnish the negatives by a clear fire, which I take care is free from dust on the bars. In summer a gas stove or spirit lamp will do equally well. I see that all doors and windows are closed, as a current of air causes dust to settle on the varnish. After warming the negative, I carefully dust it with a broad camel's hair brush; pour on the varnish from one bottle, flow it over the plate, and pour off into another bottle, and again warm the negative until it is dry. After the negatives are all varnished, I stand them on a shelf, and in the morning (by which time the varnish is quite set) I deliver them to the printer with instructions as to style of printing.

In some cases, and where proofs are required, it is better to print the proofs before varnishing. This can easily be done, without injury to the gelatine or retouching, by printing through thin sheets of talc. If any alterations are required, they can then be done before varnishing.

In conclusion, I may say that the above is the best plan arrived at by me after some years' experience. It is followed out daily by me as retoucher to a large firm, many of whose photographs are for publication.—*Photo. News.*

VULCAN'S FORTHCOMING TRANSIT, OCTOBER 12 OR 13, 1881, AND ACCOMPANYING DETAILS.

By A. F. GODDARD, Sacramento, California.

To the Editor of the Scientific American:

Some time since I addressed you upon a probable transit of Vulcan in October next, but having now reached conclusions that so nearly accord with Leverrier's mean sidereal periods of 33.0225 days, the ratio of the displacement of the nodes, and the direct inference that Mr. Wright's observance of a transit of Vulcan, October 24, 1876, reported and illustrated in your columns, the SCIENTIFIC AMERICAN, of Nov. 15, 1876, formed the very link that Leverrier's hypothesis almost grasped, I now hasten to furnish you with the evidence in another sheet, and beg your careful consideration of it. The final result shows that we may either assume now the same periods as the interval from Lescarbault to Wright required, which would give us October 12, 5h. 52m. 11s. P. M., 1881, or the same as the interval 1750 to Lescarbault, which would give us October 13, 5h. 18m. 37s. P. M., or the same as the De Cuppis and Lescarbault interval gave, which would now give us October 13, 8h. 52m. P. M., 1881; all computed for San Bernardino in longitude 117° 15' W. and 34° 45' N. from Greenwich. These hours are presumably the time for mid-transit; what its duration may be we cannot now determine, or whether it will be a full transit or only a small arc, which makes it the more necessary for careful observance to be continued on the 12th and 13th of October, as much as possible throughout sunlight, that no chances should be lost. The duration may be from ten minutes to ten hours. It is of course rather unfortunate that the hour of mid-transit is not favorable for the East, should the occurrence accord exactly with either computation; but the evidence of irregular periods, although it may point to such dates and hours, virtually shows a margin of nearly twenty-four hours from the 12th to 13th of October. It would be well, therefore, for Eastern astronomers to render all the assistance they can by observance. But it is to be hoped that competent astronomers will be deputed to take charge of the observations at Honolulu, and even Sydney, and Hong Kong, and Japan, all of which are probably situated more advantageously than the Pacific Coast. At the same time, very simple observations taken on board the ocean steamers would suffice to detect a round planet crossing the solar disk, if visible at all, and I am glad to add that the Vice-President of the Occidental and Oriental Steamship Company promptly concurred with my recommendation, so that, if the weather is favorable, they will not lose the chance of observance of Vulcan's transit.

I am in communication with the Naval Observatory, Washington, and Prof. Davidson, President of the Academy of Sciences, San Francisco, but it will be next week before I can learn results. The British Consul, W. L. Booker, Esq., of San Francisco, will, I hope, take some action in the matter also.

INTER-MERCURIAL PLANETS.

Leverrier, October, 1876, "For a transit at this node we must wait till about 1881."

Evidence of forthcoming Transit of Vulcan, October 13 or 14, 1881, computed by A. F. Goddard, Sacramento, California, July, 1881:—

Observers, Lescarbault, March 26, 1859, and Lummis, March 19, 1862: Ratio of displacement, planet at the nodes, 7 days in 3 years.

Ratio of displacement from Wright's transit, observed October 21, 1876, 11° 66' 66" 36d. at San Bernardino, Cal. (reported transit, see SCIENTIFIC AMERICAN, November 18, 1876). October 13, 1881, close relation of Leverrier's formula $k = 0$, sidereal periods 33.0225d. (*Nature*, October 26, 1876). "solution very precise," 176 synodical periods from Lescarbault to September 21, 1876, and 83 days to October 24, 1876, Wright's observance.

A. F. Goddard's proposition, divide the Lescarbault-Wright interval by 177.

Lescarbault, March 26, 4h. 35m. P. M., mid-transit, 1859, to Wright, October 24, 1h. 30m. P. M., 1876.

Lescarbault near Paris, 2½° E.; Wright, Cal., 117½° W., or 120° difference; add 8h. to Wright. Interval 6422-2045455d., requiring 177 apparent periods of 36-2896415d. each; or to Leverrier, conjunction September 21, 1876, about 6389 1530d., making 176 apparent periods of 36-3020d. each. Difference of intervals, 23-0523455d. to October 24, 1876. Example: DeCuppi-Lescarbault interval, October 2, 12 noon, 1859, to March 26d. 4h. 35m. P. M., 1859, interval 7115 19097223d., requiring 196 apparent periods of nearly 36-3020d. each. Or

from 1750, 12 noon, January 1, to Lescarbault observation March 26, 1859, interval 30897-19097223d., requiring 1,009 periods of 36-30317649d.

In applying the above data to the forthcoming transit in October, we are entitled, first, to take 50 more similar periods to the Lescarbault-Wright interval or 36-2896415d. to October 12, 5h. 52m. 21s. P. M., longitude 117½° W., 1881, making an interval of 1814-1820750d. from October 24, 1h. 30m. P. M., longitude 117½° W., 1876; or second, to take 50 more periods of 36-3020d. from October 24, 1876, to October 13, 5h. 52m. P. M., 1881; or third, to take 50 more periods of 36-30317649d. from October 24, 1876, to October 13, 5h. 18m. 37s. P. M., 1881, all three suggestions applying to San Bernardino, longitude 117½° W., latitude 34½° N., and showing the great desirability of observations at Honolulu, in longitude 156° W. from Greenwich, the Pacific Ocean, Sydney, Japan, and Hong Kong. No doubt arrangements are now being made for the observance of the transit of Mercury, November 7, although Vulcan demands our first attention, October 12 and 13, 1881, in nearly the same localities. Respectfully,

Sacramento, August 2, 1881.

A. F. GODDARD.

COMET B 1881.

At the last meeting of the California Academy of Sciences, Prof. Davidson spoke at some length concerning the comet, giving many off-hand illustrations on the blackboard, describing his observations in detail. He said a few nights before June 24, the comet at its lower declination, passed below the horizon, hence arose the popular report that there were two comets. It really appears to circle around the north star, as our own sun appears at times to those within the Arctic circle. He had ascertained its right ascension within three to four hundredths of a second by a transit instrument, and its declination by a 6½ inch equatorial telescope. He observed its physical characteristics under a power of 50 to 200 diameters. June 24, it had a well-defined nucleus, whose disk was more sharply defined than the planet Uranus. At times there existed an abnormal and irregular refraction of the atmosphere. It first presented three beams of light radiating from the central nucleus to the inner rim of the outer envelope, having considerable luminosity between them, and casting a well-defined shadow. One side of the coma or tail was brighter than the other. June 25, the envelope was less light around the nucleus, and the peculiarities of its beams had changed. With the telescope he saw six small stars through the tail, and four or five beams of light radiated from its head. June 26, these rays so multiplied as to set upon the comet's head like an expanding crown. On a subsequent night, while its nucleus still continued well defined, it took a wholly different shape. All these rapid changes indicate an intense activity and altered its whole characteristics of the shadow. The phenomenon of two apparent envelopes of light was still maintained. The following night this segmental beam of light cast a shadow almost equal to the nucleus. July 8, he found very unexpectedly that the first envelope was merging into the second, indicating a great abnormal change unlike any astronomical drawings known to him. Its tail, which had slightly exceeded 15°, had decreased nearly half a degree each night, but has retained a very fair nebulous form. For the last six or eight nights, however, he has detected no shadow, only a nebulous mass, and the breadth of its nucleus and coma or tail have each decreased, one side still appearing brightest. He used a Browning five prism spectroscopic, whose use he illustrated. He found it impossible to fully determine whether the spectrum was homogeneous and the nucleus solid, or whether special lines crossed it, showing it to be incandescent or fluid, as the atmosphere around the observatory was too unsteady. Some indications appear to lead to a belief that parts of the spectrum observed may be influenced by reflected sunlight, and some broad lines at times visible presented a spectrum like the hydrocarbons. Prof. Henry Draper says the light of the coma or tail is from the nucleus or head itself, and is not reflected sunlight. He then illustrated the orbits of the meteoric showers through which the earth passes November 10, 14, and 27. One of these goes beyond the planet Uranus, and has a period of 33 years, dating from about 1832. He gave the opinion of an eminent German astronomer, to whom was awarded the gold medal of the British Royal Astronomical Society, that these meteors were the waste particles thrown off by comets, and showed how he had demonstrated that these meteoric belts were on the exact courses of comets, whose spectrum revealed that they were composed of the same elements as the comets whose courses they occupied. When these meteors of various sizes strike out atmosphere they fuse from friction, and become very brilliant as they are rapidly melted and drawn to the surface of the earth. Astronomers now think meteoric matter the debris of comets, which lose much matter continually on their course. The doctrine of a resisting medium of ether in space, outside of the atmosphere of planets, has been exploded.

STANDARD DANIELL CELLS.

At a recent meeting of the Physical Society Dr. James Moser exhibited a novel form of Daniell cell of the gravity type intended as a standard of electromotive force. It consisted of a long glass vessel of tubular form, having a copper plate at the bottom immersed in sulphate of copper and a zinc plate at the top immersed in sulphate of zinc. The two solutions are of course separated by their densities, but, as is well known, the copper solution tends to diffuse upwards into the zinc solution and deposit pure copper on the zinc plate. This diffusion is accelerated, too, by impurities falling from the oxidized zinc plate stirring up the solution below. Dr. Moser, however, prevents the sulphate of copper rising above a well-marked line of demarcation by simply suspending a small plate of scrap zinc by a string vertically into the liquid so that the upward diffusion of the copper sulphate is arrested at the bottom of the suspended plate and copper is deposited on the latter. This cell is, however, not intended for yielding a constant current, and Professor Macleod, of the Indian Engineering College, Cooper's Hill, described a gravity Daniell devised by him for driving an electric clock. In this cell the two solutions are kept apart by surrounding the zinc plate with a cage of copper wire connected to the copper plate in the bottom of the cell. The trespassing copper solution is arrested by the cage, and copper is deposited on the wires, especially those on the upper sides of the cage immediately encircling the zinc. Dr. O. J. Lodge pointed out that this arrangement would not yield a correct standard of electromotive force, because all the copper plate was not wholly immersed in its own solution; it being a condition of accuracy that the zinc plate should be entirely immersed in the sulphate of zinc,

while the copper plate is wholly covered by the sulphate of copper. Dr. Lodge is himself the inventor of a standard Daniell, which, we believe, gives very good results. In this the copper plate and solution are contained in a glass tube dipped into the sulphate of zinc solution; and the zinc plate is contained in a glass tube open at both ends and likewise immersed in the sulphate of zinc solution. In order to reach the zinc plate, the sulphate of copper has to diffuse out of the test tube, pass down the cell to the bottom, then rise up through the solution in the open tube. This is a process requiring considerable time, and it may be further checked by laying a piece of scrap zinc on the bottom of the cell.

AMERICAN INVESTIGATIONS IN TURKEY.

CONSUL-GENERAL HEAP, of Constantinople, in a recent dispatch, informs the State Department at Washington that the Turkish authorities have determined to grant the concession desired by Prof. Charles Eliot Norton of Harvard University, of the right to investigate the remains of an ancient Greek city upon Turkish soil. It will take some weeks for the concession to go through all the red tape process of the Turkish Government, but there is no reason to doubt that the expedition will be on its way next month, and that the work will begin at the ancient city early in February. This expedition is unprecedented.

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